SECTION 146000 – ELECTRIC HOISTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. SCOPE

1. This section specifies hoisting equipment for the Mezzanine and the Hose Tower
2. Runway beams and rail are part of the building steel package and are not included in this section.

B. WORK INCLUDES THE FOLLOWING:

1. Detailed design of completed crane system including, trolley, hoists, cabling, controls, and all necessary appurtenances for a complete system for each crane.
2. Submittals and Shop drawings.
3. Installation of crane assemblies.
4. Inspection and shop testing.
5. Documentation and schedules.

1.2 REFERENCES

A. Equipment furnished under this section shall, except as otherwise noted, comply in all respects with the requirements of the following standards:

B. OSHA Occupational Safety and Health Administration Part 1926.554 - Overhead Hoists
1. Part 1910.179 – Overhead and Gantry Cranes

C. *CMAA Crane Manufacturer's Association of America

D. *ANSI / ASME
1. American National Standards Institute / American Society of Mechanical Engineers
2. ANSI / ASME B30.16 – 2003 Overhead Hoists (Underhung).

E. NEMA National Electric Manufacturer's Association NEC National Electric Code – 1999
1. Article 100, Article 240-1, Article 430-31, Article 430-51, Article
2. 610-1, Article 610-31

1.3 SUBMITTALS

A. SHOP DRAWINGS AND EQUIPMENT DATA

1. Manufacturer's product data for each hoist system, and each component within each system.
2. Wiring schematics. – ship with crane

B. OPERATIONS AND MAINTENANCE MANUALS

1. Equipment function, normal operating characteristics, and limiting conditions.
2. Assembly, installation, alignment, and maintenance instructions.
3. Lubrication and maintenance instructions.

4. Guide to “troubleshooting”.
5. Parts list.
6. As-built drawing.
7. Test results.

1.4 APPLICABLE STANDARDS

A. Contractor shall adhere to OSHA, state, and local safety guidelines, laws, rules, and regulations.
B. Contractor shall conform to all applicable ANSI, CMAA, and HMI specifications and/or standards.
C. Comply with CMAA specification 70, as applicable.
E. All electric equipment shall be UL, CSA c/us or ETL labeled.

1.5 WARRANTIES

A. Provide one-year warranty for moving parts and controls.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements herein, provide products manufactured by the following:
   1. Coffing
   2. Harrington
   3. Stahl
B. Alternate manufacturers will be considered in compliance with Section 012500.

2.2 MATERIALS

A. Components Material
   1. Trolley: Steel, ASTM A36 (or equal)
      a. Wheels Cast iron or steel
      b. Hooks Forged steel

2.3 EQUIPMENT

A. HOIST AND TROLLEY

1. Crane #1 Mezzanine
   a. Capacity: One-half (1/2) Ton
   b. Type: Suspension hung, motor driven trolley (for I-Beam Flange) with dual speed electric chain hoist
   c. Trolley speed: 35 FPM, variable frequency drive
   d. Trolley drive: Motorized
   e. Hoist speeds: 25/5 FPM, variable frequency drive
   f. Hoist type: Electric with chain hoist
   g. Hoist lift required: 20 Ft.
   h. Power Supply: 3-Phase voltage 208-230V-3-50/60
   i. Accessories: Chain Container
   j. Controls:
      1) Standard push button control station with Nema-4X enclosure.

2) Three-motion radio transmitter and receiver

2. Crane #2 Hose Tower
   a. Capacity: One-half (1/2) Ton
   b. Type: Suspension hung, motor driven trolley (for I-Beam Flange) with dual speed electric chain hoist
   c. Trolley speed: 35 FPM, variable frequency drive
   d. Trolley drive: Motorized
   e. Hoist speeds: 25/5 FPM, variable frequency closed loop
   f. Hoist type: Electric with chain hoist
   g. Hoist lift required: 30 Ft.
   h. Power Supply: 3-Phase voltage 208-230V-3-50/60
   i. Accessories: Chain Container
   j. Controls:
      1) Standard push button control station with Nema-4X enclosure.
      2) Three-motion radio transmitter and receiver

3. Trolleys shall have energy absorbing bumpers.
4. All hoist and trolley wiring shall be in rigid or flexible conduit.

D. POWER SUPPLY

1. Power supply for the hoist and trolley shall be 208/230 volt, 3 ph., 60 Hz. All power required for the operation of the hoist, and trolley shall be developed from this source.

E. CONTROLS

The following controls shall be used as applicable:
1. Six-way operation, plug-in pushbutton pendant.
2. Secondary operation via radio transmitter and receiver.
3. Pushbutton and radio shall be clearly marked with hoist, and trolley travel directions.

G. PAINTING
1. Hoist and trolley shall be factory painted (2-part epoxy) per manufacturer's standards.

PART 3 – EXECUTION (if applicable to crane manufacturer)

3.1 INSTALLATION AND INSPECTION

A. Inspect structure and crane rail erection for conformance with reviewed shop drawings and contract documents prior to installation of equipment.
B. General contractor shall engage a third party surveyor that is not in the business of manufacturing overhead cranes or hoists to ensure straightness and levelness of runway for entire length before installation of crane(s).
C. Runway beams and/or rails not supplied or installed by crane provider shall comply with manufacturer's span, straightness, and elevation tolerances as specified by CMAA.
D. Install trolley and hoist mechanisms in compliance with manufacturer's printed installation instructions.

3.2 TESTING

A. Provide on-site load testing.

B. Operate equipment through a complete lift and lowering cycle and through a complete travel of the trolley to determine that the equipment shall perform smoothly and safely and that cable length is sufficient to permit operation from desired floor levels. All tests shall be carried out with the equipment loaded at 125 percent of capacity.
C. Correct any defects without any expense to the Owner.

3.3 USE BY CONTRACTOR

A. If crane is used by the Contractor, it shall be repaired, repainted, and otherwise refurbished to like new condition prior to its acceptance. The crane provider shall then perform a detailed inspection at owner's cost prior to warranty taking effect. The Contractor assumes all responsibility for operation and maintenance until the crane has been accepted by Owner.

3.4 CLEANUP

A. Upon completion of work, area shall be cleaned and restored to original condition, acceptable to the Owner.

END OF SECTION 146000

SECTION 200500 - MECHANICAL GENERAL REQUIREMENTS

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 work of this Section.

1.2 SUMMARY

A. This Section includes mechanical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 01 Specification Sections.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
3. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
4. ABMA - American Boiler Manufacturers Association; www.abma.com.
5. AGA - American Gas Association; www.aga.org.
6. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
7. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
8. ANSI - American National Standards Institute; www.ansi.org.
9. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
10. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
11. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
12. ASTM - ASTM International; www.astm.org.
13. AWS - American Welding Society; www.aws.org.
14. AWWA - American Water Works Association; www.awwa.org.
15. CDA - Copper Development Association; www.copper.org.
16. CGA - Compressed Gas Association; www.cganet.com.
17. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
18. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
19. CSI - Construction Specifications Institute (The); www.csiresources.org.
20. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
21. FM Approvals - FM Approvals LLC; www.fmglobal.com.
22. HI - Hydraulic Institute; www.pumps.org.
23. ICC - International Code Council; www.iccsafe.org.
24. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
25. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
26. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
27. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org
28. NADCA - National Air Duct Cleaners Association; www.nadca.com.
29. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
30. NEBB - National Environmental Balancing Bureau; www.nebb.org.
31. NECA - National Electrical Contractors Association; www.necanet.org.
32. NEMA - National Electrical Manufacturers Association; www.nema.org.
33. NETA - InterNational Electrical Testing Association; www.netaworld.org.
34. NFPA - National Fire Protection Association; www.nfpa.org.
35. NSF - NSF International; www.nsf.org.
36. NSPE - National Society of Professional Engineers; www.nspe.org.
37. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
38. STI - Steel Tank Institute; www.steeltank.com.
39. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
40. UL - Underwriters Laboratories Inc.; www.ul.com.
41. USGBC - U.S. Green Building Council; www.usgbc.org.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Systems Components Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

1.5 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified and as indicated on Drawings.

1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.

1. Notify the Architect/Engineer in writing before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations.
2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to A/E, the Contractor shall bear all costs arising from corrective measures.

C. Source Limitations: Obtain equipment and other components of the same or similar systems through one source from a single manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Perform work to avoid interference with the work of other trades. Remove and relocate work which in the opinion of the Owner's Representatives causes interference.

G. Labeling Requirement for Packaged Equipment: Electrical panels on packaged mechanical equipment shall bear UL label or label of other Nationally Recognized Testing Laboratory (NRTL) (Intertek, CSA, etc.).

1.6 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for Mechanical Work shall be secured and paid for by the Contractor. All Work shall conform to all applicable codes, rules and regulations.

B. Rules of local utility companies shall be complied with. Check with each utility company supplying service to the installation and determine all devices including, but not limited to, all valves, meter boxes, and meters which will be required and include the cost of all such items in proposal.

C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

D. Refer to Division 22 Section “Domestic Water Piping” for purchase and installation of potable water meters.

1.7 DRAWINGS

A. The drawings show the location and general arrangement of equipment, piping and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly. Provide fittings, valves, and accessories as required to meet actual conditions.

C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The Architectural and Structural Drawings take precedence in all matters pertaining to the building structure, Mechanical Drawings in all matters pertaining to Mechanical Trades and Electrical Drawings in all matters pertaining to Electrical Trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.8 MATERIAL AND EQUIPMENT MANUFACTURERS

A. Equipment: All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the

plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, piping, sheet metal, electrical work, and building alterations shall be included in the original Bid.

C. All package unit equipment and skid mounted mechanical components that are factory assembled shall meet, in detail, the products named and specified within each section of the Mechanical and Electrical Specifications.

D. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment scheduled on the Drawings. 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 with no additional cost to project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1. Where equipment changes are made that involve additional Electrical Work (larger size motor, additional wiring of equipment, etc.) the Mechanical Trades involved shall compensate the Electrical Trades for the cost of the additional Work required.

1.9 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

B. No contract sum adjustments or contract time extensions will be made for Contractor claims arising from conditions which were or could have been observable, ascertainable or reasonably foreseeable from a site visit or inquiry into local conditions affecting the execution of the work.

1.10 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 01 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, piping, sheet metal, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid, but will not affect the awarding of the contract.

1.11 ACTION SUBMITTALS

A. Submit for review in compliance with Division 01.

B. Equipment and material submittals required are indicated in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating and Air Conditioning Sections. Refer to Division 01 for submittal quantities.

C. Submittals shall be in groupings of similar or related items. Plumbing fixture submittals shall be in one package including all fixtures intended to be used for this project. Incomplete submittal groupings will be returned “Rejected”. Submit product data with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.

D. Submittals shall be project specific. Standard detail drawings and schedule not clearly indicating which data is associated with this Project will be returned “Rejected”.

E. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be included with the submittal for approval.

1.12 INFORMATIONAL SUBMITTALS

A. Shop Drawings:

1. Prepare shop drawings to scale for the Architect/Engineer for review.
2. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.
3. No equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. Review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action indicated is subject to the requirement of the plans and specifications.

    a. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.
    b. Contractor is responsible for:

        1) Dimensions, which shall be confirmed and correlated at the job site.
        2) Fabrication processes and techniques of construction.
        3) Quantities.
        4) Coordination of Contractor’s work with all other trades.
        5) Satisfactory performance of Contractor’s work.
        6) Temporary aspects of the construction process.

B. Coordination Drawings:

1. Submit project specified coordination drawings for review in compliance with Division 01 Specification Sections.

1.13 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Instructional Manuals:

1. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.
2. Provide complete operation and maintenance instructional manuals covering all mechanical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. One copy of all manuals shall be furnished for Owner. Maintenance and operating instructional manuals shall be provided when construction is approximately 75 percent complete.
3. Format: Submit operation and maintenance manuals in the following format:

    a. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.

        1) Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
        2) Enable inserted reviewer comments on draft submittals.

4. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:

    a. Routine maintenance procedures.
    b. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
    c. Trouble-shooting procedures.
    d. Contractor's telephone numbers for warranty repair service.
    e. Submittals.
    f. Recommended spare parts list.
    g. Names and telephone numbers of major material suppliers and subcontractors.
    h. System schematic drawings.

B. Record Drawings:

1. Submit record drawings in compliance with Division 01.
2. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or vellum which have been neatly marked to represent as-built conditions for all new mechanical work.
3. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

C. Warranties:

1. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner's satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.
2. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.14 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 24 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.

C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.

E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.15 WARRANTY

A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner's satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 REFRIGERANT HANDLING

A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:

1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
3. United States Environmental Protection Agency (US EPA) requirements of Section 8 08 (Prohibition of Venting and Regulation of CFC) and applicable State and Local regulations of authorities having jurisdiction.

B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations.

3.2 TEMPORARY SERVICES

A. Provide temporary service as described in Division 01.

3.3 WORK INVOLVING OTHER TRADES

A. Certain items of equipment or materials specified in the Mechanical Division may have to be installed by other trades due to code requirements or union jurisdictional requirements. In such instances, the Contractor shall complete the work through an approved, qualified subcontractor and shall include the full cost for same in proposal.

3.4 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.

B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.

C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.

D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

E. Operation of the following systems shall be demonstrated:

1. Air Handling Systems.
2. Refrigeration Systems.
3. Heating Systems.
4. Domestic Hot Water Heaters.
5. Domestic Hot Water Mixing Stations.
6. Compressed Air Systems.
7. Chemical Treatment Systems.
8. Energy Recovery Systems.
9. Temperature Controls.
10. Building Automation System.
11. Exhaust Systems.

F. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

END OF SECTION 200500

SECTION 200510 - BASIC MECHANICAL MATERIALS AND METHODS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 22 Section “Domestic Water Piping” for flushing and cleaning of potable water piping.
3. Division 23 Section “Piping Systems Flushing and Chemical Cleaning” for flushing and cleaning of HVAC piping.

1.2 SUMMARY

A. This section includes mechanical materials and installation methods common to mechanical piping systems, sheet metal systems and equipment. This section supplements all other Division 20, 21, 22, and 23 Mechanical Sections, and Division 01 Specification Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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 in duct shafts.

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. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Mechanical sleeve seals.
3. Escutcheons.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Brazing Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

B. Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

D. Comply with NSF 372, “Drinking Water System Components – Lead Content” for potable domestic water piping and components.

E. 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.
3. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

F. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

G. Soldering: Qualify processes and operators according to AWS B2.3/2.3M, "Specification for Soldering Procedure and Performance Qualification."

H. Installer Qualifications:

1. Installers of Grooved Components: Installers shall be certified by the grooved component manufacturer as having been trained and qualified to join piping with grooved couplings, fittings, and specialties.

2. 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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Provide adequate weather protected storage space for all mechanical equipment and materials deliveries to the job site. Storage locations will be designated by the Owner's Representative. Equipment stored in unprotected areas must be provided with temporary protection.

1. Protect equipment and materials from theft, injury or damage.
2. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.
3. Materials with enamel or glaze surface shall be protected from damage by covering and/or coating as recommended in bulletin "Handling and Care of Enameled Cast Iron Plumbing Fixtures", issued by the Plumbing Fixtures Manufacturer Association, and as approved.
4. Electrical equipment furnished by Mechanical Trades and installed by the Electrical Trades: Turn over to Electrical Trades in good condition, receive written confirmation of same.
5. 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.
6. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations. Coordinate with other trades to ensure accurate locations and sizes of mechanical spaces, chases, slots, shafts, recesses and openings.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Install Work to avoid interference with work of other trades including, but not limited to, Architectural and Electrical Trades. Remove and relocate any work that causes an interference at Contractor's expense.

D. Coordinate requirements for and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

E. The mechanical trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.

1. All patching and repair of any such damaged work shall be performed by the trades which installed the work. The cost shall be paid by the Mechanical Trades.

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21, 22, and 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21, 22, and 23 piping Sections for special joining materials not listed below.

B. Unions: Pipe Size 2 Inches and Smaller:

1. Ferrous pipe: Malleable iron ground joint type unions.
2. Unions in galvanized piping system shall be galvanized.
3. Copper tube and pipe: Bronze unions with soldered joints.

C. Flanges: Pipe Sizes 2-1/2 Inch and Larger:

1. Ferrous pipe: Standard weight, forged steel weld neck flanges.
2. Copper tube and pipe: Slip-on bronze flanges.

D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. Square head bolts and nuts are not acceptable.

F. Solder Filler Metals: ASTM B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.

G. Brazing Filler Metals: Alloys meeting AWS A5.8.

1. Use Type BcuP Series, silver-bearing, copper-phosphorus alloys for joining copper or bronze socket fittings with copper pipe. Flux is prohibited unless used with bronze fittings.
2. Use Type Bag Series, cadmium-free silver alloys for joining copper with steel, stainless steel, or other ferrous alloys.

H. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

I. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

J. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

K. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 PIPE THREAD COMPOUNDS

A. General: Pipe thread compounds for the fluid service compatible with piping materials provided.

B. Potable Water Service and Similar Applications: Compounds acceptable to U.S. Department of Agriculture (USDA) or Food and Drug Administration (FDA). Compounds containing lead are prohibited.

C. Galvanized Steel: Inorganic zinc-rich coatings or corrosion inhibited proprietary compounds to coat raw carbon steel surfaces, in lieu of subsequent painting. Compounds containing lead are prohibited.

1. Manufacturers:

a. Carboline "Carbo-Zinc 12."
b. Tnemec.
c. Koppers.

D. Natural Gas System: Use either of the following:

1. Tetrafluoroethylene (Teflon) tape 2 to 3 mils thick for threaded joints.

a. Manufacturers:

1) Cadillac Plastic.
2) Permacel.
3) Other approved.

2. Lead-free pipe thread compounds suitable for service.

a. Manufacturers:

1) HCC Holdings, Inc.; Hercules Pro Dope.
2) Mill-Rose Company (The); Clean-Fit Products; Blue Monster Thread Sealant.
3) Oatey; Great Blue Pipe Joint Compound.
4) RectorSeal LLC: A CSW Industrials Company; No. 5, No.5 Special, and No. 5 Sub-Zero Pipe Thread Sealants.

2.5 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. IPEX Inc. (formerly Eslon Thermoplastics).

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

a. NIBCO INC.
b. NIBCO, Inc.; Chemtrol Div.

D. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.
e. Can-Tex Industries Division of Harsco Corp. “CT-Adaptors”.
f. Joint Inc., “Caulder”.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Brass Unions, Brass Nipples, Brass Couplings: For systems up to 286 deg F.

D. Dielectric-Flange Kits: Include full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Capitol Manufacturing Co.
d. GF Piping Systems; George Fischer Central Plastics.
e. Epco Sales, Inc.
f. Pipeline Seal and Insulator, Inc.
g. Watts Water Technologies, Inc.; Watts Regulator Co.
h. Zurn Industries, Inc.; Wilkins Div.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Nipple/Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, male NPT threaded, or grooved ends; and 300-psig minimum working pressure at 230 deg F.

1. Manufacturers:

a. ASC Engineered Solutions; Gruvlok Manufacturing; DI-LOK Nipples.
b. Elster Group; Perfection Corp.; ClearFlow.
c. Precision Plumbing Products, Inc.; ClearFlow.
d. Sioux Chief Manufacturing Co., Inc.
e. Tyco Fire & Building Products; Grinnell Mechanical Products; Figure 407 ClearFlow.
f. Victaulic Co. of America; Style 47 ClearFlow.

2.7 MODULAR MECHANICAL SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve or pipe and core drilled hole.

1. Manufacturers:

a. Advance Products & Systems, Inc.; Innerlynx.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.; Thunderline Link Seal.

2. Sealing Elements: EPDM 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. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 SLEEVES

A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall black.

B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall galvanized, plain ends.

C. Water Stop: Cast or ductile-iron; fabricated steel; PVC; or rotationally molded HDPE pipe; with plain ends and integral water stop, unless otherwise indicated.

1. Manufacturers:

a. Advance Products & Systems, Inc.; Infinity and Gal-Vo-Plast Sleeves.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.9 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping or Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
e. Bare Piping in Unfinished Service Spaces or Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.

2.10 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.11 EPOXY BONDING COMPOUND

A. Two-component system suitable for bonding wet or dry concrete to each other and to other materials.

B. Manufacturers:

1. Euco 452 #450; Euclid Chemical Co.
2. Epobond; L & M Construction Chemicals.
3. Sikadur 87; Sika Corp.

2.12 LEAK DETECTOR SOLUTION

A. Commercial leak detector solution for pipe system testing.

B. Manufacturers:

1. American Gas and Chemicals Inc.; Leak Tec.
2. Cole-Parmer Inst. Co.; Leak Detector.
3. Guy Speaker Co. Inc.; Squirt 'n Bubbles.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Refer to piping application schedules on the Drawings.

B. Install piping according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems, and in accordance with manufacturer’s instructions.

C. 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. The Drawings shall be followed as closely as elements of construction will permit.

D. During the progress of construction, protect open ends of pipe, fittings, and valves to prevent the admission of foreign matter. Place plugs or flanges in the ends of all installed work whenever work stops. Plugs shall be commercially manufactured products.

E. Prior to and during laying of pipe, maintain excavations dry and clear of water and extraneous materials. Provide minimum 4 inches of clearance in all directions for pipe passing under or through building grade beams.

F. Clean and lubricate elastomer joints prior to assembly.

G. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

H. Install piping to conserve building space and not interfere with use of space.

I. Group piping whenever practical at common elevations.

J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

1. Install piping to allow for expansion and contraction at locations where piping crosses building or structure expansion joints.

K. Slope piping and arrange systems to drain at low points.

L. Slope horizontal piping containing non-condensable gases 1 inch per 100 feet, upward in the direction of the flow.

M. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

N. 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.

O. In concealed locations where piping, other than black steel, cast-iron, or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1-1/2 inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1/16 inch thick steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches above sole plates and below top plates.

P. Do not penetrate building structural members unless specifically indicated on drawings.

Q. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.

R. Install valves with stems upright or horizontal, not inverted.

S. Provide clearance for installation of insulation and access to valves and fittings.

T. Install piping to permit valve and equipment servicing. Do not install piping below valves and/or terminal equipment. Do not install piping above electrical equipment.

U. Install piping at indicated slopes. Provide drain valves with hose end connections and caps at all piping low points, where piping is trapped and at all equipment.

V. Install piping free of sags and bends.

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

X. Unless otherwise indicated or specified, install branch connections to mains using tee fittings in main pipe:

1. Branch connected to bottom of main pipe for HVAC systems. Side connection is acceptable. Connection above centerline of main is unacceptable. For up-feed risers, connect branch to top of main pipe.
2. Branch connected to top of main for steam and condensate, plumbing systems, compressible gasses, and vacuum.

Y. Install piping to allow application of insulation.

Z. Select system components with pressure rating equal to or greater than system operating pressure.

AA. After completion, fill, clean, and treat systems. Refer to Division 23 Sections “Hydronic Piping,” “Piping Systems Flushing and Chemical Cleaning,” and “HVAC Water Treatment.”

BB. Install escutcheons for penetrations of walls below ceiling, and ceilings.

CC. Sleeves are not required for core-drilled holes in poured concrete walls.

DD. Permanent sleeves are not required for holes formed by removable PE sleeves in poured concrete walls.

EE. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces of walls.

    a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.
    b. 0.375 Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.
    c. Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.
    d. 0.375 Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.
    e. For pipes penetrating floors with membrane water proofing provide cast iron sleeve with clamping flanges. Secure/seal membrane to sleeves with clamping flanges.

4. Seal sleeves in concrete floors roof slabs and masonry walls with grout.
5. Seal sleeves in plaster/gypsum-board partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.
6. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

FF. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.

1. Install Schedule 40 galvanized steel pipe for sleeves smaller than 12 inches in diameter.
2. Install 0.375 galvanized steel pipe for sleeves 12 inches and larger in diameter.
3. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

GG. New, Poured Concrete, Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Install water stop sleeves prior to pour. Seal pipe penetrations using modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.

1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

HH. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

1. Seal openings around pipes in sleeves through walls, floors and ceilings, and where floors, fire rated walls and smoke barriers are penetrated. Firestop materials shall be UL listed and shall have a fire rating equal to or greater than the penetrated barrier.
2. Refer to Division 07 Specification Sections for materials and UL Classified firestop systems.

II. Pipe Roof Penetration Enclosures:

1. Coordinate delivery of roof penetration enclosures to jobsite.
2. Locate and set curbs on roof.
3. Framing, flashing, and attachment to roof structure are specified under Division 07.
4. Attach cap to curbs, cut pipe boots to fit pipe, and clamp boots to pipe or conduit.

JJ. Verify final equipment locations for roughing-in.

KK. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems.

B. Cut piping square.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, oil, and debris from inside and outside of pipe and fittings before assembly.

E. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

F. Use standard long sweep pipe fittings for changes in direction. No mitered joints or field fabricated pipe bends will be permitted. Short radius elbows may be used where specified or specifically authorized by the Architect.

G. Make tee connections with screwed tee fittings, soldered fittings or specified welded connections. Make welded branch connections with either welding tees or forged branch outlet fittings in accordance with ASTM A234, ANSI B16.9 and ANSI B16.11. For forged branch outlets, furnish forged fittings flared for improved

flow where attached to the run, reinforced against external strains and to full pipe-bursting strength requirements. "Fishmouth" connections are not acceptable.

H. Use eccentric reducers for drainage and venting of pipe lines; bushings are not permitted.

I. Provide pipe openings using fittings for all systems control devices, thermometers, gauges, etc. Drilling and tapping of pipe wall for connections is prohibited.

J. Provide temperature sensing device thermal wells and similar piping specialty connections.

K. Provide instrument connections except thermal wells with specified isolating valves at point of connection to system.

L. Locate instrument connections in accordance with manufacturer's instructions for accurate read-out of function sensed. Locate instrument connections for easy reading and service of devices.

M. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

N. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

O. 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 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.

P. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

1. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

Q. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on gaskets and bolt threads.

1. Assemble flanged joints with fresh-stock gasket and hex head nuts, bolts or studs. Make clearance between flange faces such that the connections can be gasketed and bolted tight without strain on the piping system. Align flange faces parallel and bores concentric; center gaskets on the flange faces without projection into the bore.
2. Lubricate bolts before assembly to insure uniform bolt stressing. Draw up and tighten bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Do not mate a flange with a raised face to a companion flange with a flat face; machine the raised face down to a smooth matching surface and use a full face gasket. After the piping system has been tested and is in service at its maximum temperature, check bolting torque to provide required gasket stress.

R. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Galvanized piping shall be cut grooved to prevent damage to galvanizing on internal pipe surfaces. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

S. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

T. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Refer to Application Schedules on the Drawings.

U. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

V. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

W. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

X. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.

3.3 ACCESS DOORS

A. Provide access doors for installation by architectural trades Provide access doors in the walls, as required to make all valves, controls, coils, motors, air vents, filters, electrical boxes and other equipment installed by the Contractor accessible. Minimum size 12 inches x 12 inches. Provide access doors in the ceiling, for accessibility as mentioned above, 24 inches x 24 inches minimum size. Areas with accessible ceilings (ceilings where lay-in panels are not fastened in place and can be individually removed without removal of adjacent tiles) will not require access doors. Refer to Division 08 Section "Access Doors and Frames" for manufacturers and model numbers and additional information.

B. When access doors are in fire resistant walls or ceilings, they shall bear the Underwriters' Laboratories, Inc., Label, with time design rating equal to or greater than the wall or ceiling unless they were a part of the tested assembly.

3.4 EQUIPMENT CONNECTIONS

A. Make connections to equipment, fixtures, and other items included in the work in accordance with the submittals and rough-in measurements furnished by the manufacturers of the particular equipment furnished.

1. Any and all additional connections not shown on the drawings but shown on the equipment manufacturer's submittal or required for the successful operation of the equipment shall be installed as part of this Contract at no additional charge to the Owner.

B. All piping connections to pumps, coils, and other equipment shall be installed without strain at the pipe connection of this equipment. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.
2. Install flanges, in piping NPS 2-1/2 and larger, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated. Housekeeping pad locations and sizes shall be coordinated by mechanical contractor prior to the placement of concrete slabs.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. For suspended equipment, furnish and install all inserts, rods, structural steel frames, brackets and platforms required. Obtain approval of Architect for same including loads, locations and methods of attachment.

F. Equipment Rigging Over Roof Areas: Protect building structure against damage during equipment rigging. Make provisions to distribute load of equipment to main roof structure, and to prevent damage to roof decking, roofing, or purlins.

G. The Contract Documents indicate items to be purchased and installed. The items are noted by a manufacturer's name, catalog number and/or brief description. The catalog number may not designate all

the accessory parts for a particular application. Arrange with the manufacturer for the purchase of all items required for a complete installation.

3.7 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

A. Concrete housekeeping pads for floor mounted mechanical equipment shall be provided by Architectural Trades.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.

1. Construct concrete bases as shown on Drawings or specified, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section.

3.9 JACKING OF PIPE

A. Do not jack pipe in place except upon prior approval of proposed materials and complete details of methods.

3.10 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.11 CUTTING, CORING AND PATCHING

A. Refer to Division 01 Specification Sections for requirements for cutting, coring, patching and refinishing work necessary for the installation of mechanical work.

B. All cutting, coring, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.12 EXCAVATION AND BACKFILLING

A. Refer to Division 31 Specification Sections.

B. Provide all excavation, trenching, tunneling and backfilling required for the mechanical work.

C. Provide all pumping and/or well pointing required for the mechanical work.

D. Provide foundations if required to support underground piping.

E. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

3.13 FLASHING

A. Provide all flashing required for mechanical work. Refer to Division 07 Specification Sections.

3.14 LUBRICATION

A. Provide all lubrication for the operation of the equipment until acceptance by the Owner. Contractor is responsible for all damage to bearings up to the date of acceptance of the equipment. Protect all bearings and shafts during installation. Thoroughly grease steel shafts to prevent corrosion. Provide covers as required for proper protection of all motors and other equipment during construction.

3.15 FILTERS

A. Provide and maintain filters in air handling systems throughout the construction period and prior to final acceptance of the building. Do not run air handling equipment, without all prefilters and final filters as specified.

B. Immediately prior to final building acceptance by the Owner, Contractor shall:

1. Replace all disposable type air filters with new units.

3.16 CLEANING

A. Each Mechanical Trade shall be responsible for removing all debris daily as required to maintain the work area in a neat, orderly condition.

B. After equipment and HVAC water piping systems have been completed and tested, each entire system shall be cleaned and flushed. Refer to Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.

C. Flushing, cleaning, and disinfection of domestic water piping is specified in Division 22 Section “Domestic Water Piping.”

D. Exterior surfaces of all piping, ductwork and equipment shall be wiped down to remove excess dirt and debris prior to concealment by Architectural Trades work.

E. Upon completion of work in each respective area, clean and protect work. Just prior to final acceptance, perform additional cleaning as necessary to provide clean equipment and areas to the Owner.

END OF SECTION 200510

SECTION 200513 - MOTORS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section "Mechanical Vibration Controls" for mounting motors and vibration isolation devices.
3. Division 20 Section “Variable Frequency Controllers”.
4. Division 21, 22, and 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed motors.

1.3 DEFINITIONS

A. ABMA: American Bearing Manufacturers Association. (Formerly AFBMA: Anti-Friction Bearing Manufacturers Association.)

B. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

C. Packaged Self Contained Equipment: Equipment which includes component mechanical and electrical equipment mounted on common bases, skids or frames or in common enclosures with internal control and power wiring factory installed and ready to accept a single electrical service connection. Provide the equipment complete with enclosed controllers, main disconnect switches, control transformers, control devices, wiring and accessories as required.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:

1. Compatible with the following:

a. Variable frequency controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate electrical scope of work to be provided by Division 20, 21, 22, and 23 with this Section, related Division 20, 21, 22, and 23 Specifications, Division 26 Specifications and the Drawings.

C. Electrical work provided under Division 20, 21, 22, and 23: Furnish UL Listed components in accordance with this section, Division 26, and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.

D. Furnished, installed and wired under Division 20, 21, 22, and 23 unless otherwise indicated:

1. Disconnected components in packaged self-contained equipment that are so constructed that components of wiring must be disconnected for shipment and reconnected after installation.

E. Furnished and installed under Division 20, 21, 22, and 23 and wired under Division 26 unless otherwise indicated:

1. Motors required for mechanical equipment
2. Packaged Self-Contained Equipment:

a. Provide equipment ready to accept a single electrical service connection.
b. For equipment with remote mounted control panels, provide mounting of the control panel and external wiring from the control panel to the package self-contained equipment.

3. Variable frequency controllers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Dayton.
2. Toshiba Intl.
3. Baldor Electric/Reliance.
4. Rockwell Automation/Allen-Bradley.
5. Nidec Motor Corporation; U.S. Electrical Motors.
6. Regal Beloit/GE Commercial Motors.
7. Regal Beloit/Leeson.
8. Regal Beloit/Marathon.
9. Siemens.

2.2 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed motors except as follows:

1. Different ratings, performance, or characteristics for a motor are specified in another Section.
2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
3. Submersible motors integral to pumps and excluded from NEMA and EISA standards.

B. Electrical Power Supply Characteristics: Coordinate electrical system requirements with Division 26.

C. Electrical Power System Characteristics: As scheduled on the Drawings.

D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

2.3 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase, unless otherwise indicated.

B. Motors Smaller Than 1/2 HP: Single phase, unless otherwise indicated.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

G. 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.

H. Brake Horsepower Input: Shall not exceed 90 percent of the rated motor horsepower.

I. Enclosure: Open dripproof (ODP) for motors installed indoors and out of the airstream. Totally-enclosed fan-cooled (TEFC) for motors installed outdoors or within the airstream.

2.4 POLYPHASE MOTORS

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

B. Efficiency: Fire pump motors, C-face motors, JP and JM frame motors, and motors over 200 horsepower shall be energy efficient motors. Efficiency of the motor shall be determined based on the NEMA MG1. The minimum efficiencies, nominal efficiencies and shall meet or exceed Table 12-11.

	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
1	82.5	81.5	82.5	81.5
1.5	84	82.5	84	82.5
2	84	82.5	84	82.5
3	86.5	85.5	87.5	86.5

	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
5	87.5	86.5	87.5	86.5
7.5	88.5	87.5	89.5	88.5
10	89.5	88.5	89.5	88.5
15	91	90.2	91	90.2
20	91	90.2	91	90.2
25	91.7	91	92.4	91.7
30	92.4	91.7	92.4	91.7
40	93	92.4	93	92.4
50	93	92.4	93	93
60	93.6	93	93.6	93
75	94.1	93.6	94.1	93.6
100	94.1	93.6	94.5	94.1
125	94.5	94.1	94.5	94.1
150	95	94.5	95	94.5
200	95	94.5	95	94.5

	1200 RPM OPEN DRIP-PROOF MOTORS 6 POLE		3600 RPM OPEN DRIPPROOF MOTORS 2 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
1	80	78.5	--	--
1.5	84	82.5	82.5	81.5
2	85.5	84	84	82.5
3	86.5	85.5	84	82.5
5	87.5	86.5	85.5	84
7.5	88.5	87.5	85.5	86.5
10	90.2	89.5	88.5	87.5
15	90.2	89.5	89.5	88.5
20	91	90.2	90.2	89.5
25	91.7	91	91	90.2
30	92.4	91.7	91	90.2
40	93	92.4	91.7	91
50	93	93	92.4	91.7
60	93.6	93	93	92.4
75	93.6	93	93	92.4
100	94.1	93.6	93	92.4
125	94.1	93.6	93.6	93
150	94.5	94.1	93.6	93
200	94.5	94.1	94.5	94.1

C. Efficiency: Motors 1 horsepower to 200 horsepower shall be premium efficient motors meeting requirements of NEMA Premium Efficiency Motor Program. Efficiency of the motor shall be determined based on the NEMA MG1. The nominal efficiencies shall meet or exceed Table 12-12.

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated 600 Volts or Less (Random Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated Medium Volts for 5kV or Less (Form Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
250	95.0	95.0	94.5	95.0	95.0	95.0
300	95.0	95.0	94.5	95.0	95.0	95.0
350	95.0	95.0	94.5	95.0	95.0	95.0
400	95.0	95.0	94.5	95.0	95.0	95.0
450	95.0	95.0	94.5	95.0	95.0	95.0
500	95.0	95.0	94.5	95.0	95.0	95.0

D. Stator: Copper windings, unless otherwise indicated.

1. Multispeed motors shall have separate winding for each speed.

E. Rotor: Squirrel cage, unless otherwise indicated.

F. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 120,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

G. Temperature Rise: Match insulation rating, unless otherwise indicated.

H. Insulation: Class F, unless otherwise indicated.

I. Code Letter Designation:

1. Motors 10 HP and Larger: NEMA starting Code (KVA Code) F or G.
2. Motors Smaller Than 10 HP: Manufacturer's standard starting characteristic.
3. Fire Pump Motors: NEMA starting Code (KVA Code) B.

J. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

1. Finish: Gray enamel.

K. Sound Level: Not to exceed NEMA MG-1 12.54.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

B. Shaft Grounding: Provide a means to protect motor from common mode currents.

1. Required for:

a. Motors used with variable frequency controllers.
b. Motors 100 HP and larger.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Electro Static Technology, Inc.; Aegis SGR Conductive Microfiber.

C. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

2.6 ELECTRONICALLY COMMUTATED MOTOR (ECM)

A. Furnish for equipment where specified or scheduled with ECM.

1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
6. Integrated motor protection verified by UL to protect equipment against over-/undervoltage, overtemperature of motor, electronics, or both, overcurrent, locked rotor, and dry run (no-load condition).

2.7 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. 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.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. All three phase motors 1/2 HP and above shall be tested by the Testing Agency.

B. Prepare for acceptance tests as follows:

1. Check motor nameplates for horsepower, speed, phase and voltage.
2. Check coupling alignment and shaft end play.
3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
4. Test interlocks and control features for proper operation.
5. Verify that current in each phase is within nameplate rating.

C. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
2. Jog motor as required to verify proper phase and shaft rotation. Immediately after start-up, check bearing temperature and smooth operation. Take current reading at full load using a clamp-on ammeter. If ammeter reading is over the rated full load current, determine reason for discrepancy and take necessary corrective actions. Record all readings, motor nameplate data and overload heater data.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.2 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 200513

SECTION 200516 - PIPE FLEXIBLE CONNECTORS, EXPANSION FITTINGS AND LOOPS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Refrigerant Piping.”

1.2 DEFINITIONS

A. BR: Butyl rubber.

B. CR: Chlorosulfonated polyethylene synthetic rubber (Neoprene).

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 150 percent of maximum axial movement between anchors.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pipe flexible connector, expansion joint and alignment guide indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
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.

B. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pipe expansion joints to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

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 FLEXIBLE CONNECTORS

A. Rubber Flexible Connectors/Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods or cables, and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

1. Manufacturers:

a. Flex-Weld, Inc./Keflex.
b. Mason Industries, Inc.; Mercer Rubber Co.
c. Metraflex, Inc.
d. Senior Flexonics, Inc.; Pathway Division.
e. Twin City Hose, Inc.
f. Vibration Mountings & Controls, Inc.

2. Arch Type: Multiple arches.
3. Spherical Type: Multiple spheres.

a. Working Pressure Ratings for NPS 1-1/2 to NPS 4: 225 psig at 170 deg F.

4. Material: EPDM.
5. End Connections: Full-faced, integral, steel flanges with steel retaining rings and female union.

B. Hose and Braid Flexible Connectors:

1. Manufacturers:

a. Adsco Manufacturing, LLC.
b. Flex-Hose Co., Inc.
c. Flex-Weld, Inc.
d. Hyspan Precision Products, Inc.
e. Metraflex, Inc.
f. Senior Flexonics, Inc.; Pathway Division.
g. Twin City Hose, Inc.

2. Flexible Connectors for Copper Piping: Multiple-ply phosphor-bronze corrugated hose with bronze outer braid, copper ferrule, and copper pipe end connections.
3. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
4. Maximum Temperature Rating: 450 deg F for copper piping connectors, 800 deg F for steel piping connectors.

PART 3 - EXECUTION

3.1 FLEXIBLE CONNECTOR APPLICATIONS

A. Use rubber flexible pipe connectors at the inlet and outlet water connections of base mounted pumps, chillers, and cooling towers, unless otherwise indicated.

1. Rubber Flexible Connectors for Pipe Sized NPS 2 and Smaller: Twin-sphere with female union end connections.
2. Rubber Flexible Connectors for Pipe Sized NPS 2-1/2 and Larger: Twin-sphere with floating flange end connections.

B. Use hose and braid flexible pipe connectors at the inlet and outlet water connections of base mounted pumps, chillers, and cooling towers, unless otherwise indicated.

1. Flexible Connectors: Stainless steel hose and braid style with threaded end connections for pipe sized NPS 2 and smaller.
2. Flexible Connectors: Stainless steel hose and braid style with steel flange end connections for pipe sized NPS 2-1/2 and larger.

C. Flexible Pipe Connectors for Refrigerant Pipe: Refer to Division 23 Section “Refrigerant Piping.”

END OF SECTION 200516

SECTION 200519 - METERS AND GAGES

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 21 Section “Fire-Suppression Piping” for listed or approved pressure gages.
4. Division 21 fire pump sections for fire-pump flowmeter systems.
5. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
6. Division 23 Section "Fuel Gas Piping" for gas utility meters.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Schedule for the following indicating manufacturer's number, scale range, and location for each:

1. Thermometers.
2. Gages.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

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 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Miljoco Corporation.
3. REOTEMP Instrument Corporation.
4. Trerice, H. O. Co.
5. Weiss Instruments, Inc.
6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum or Chrome-plated brass, 9 inches long.

C. Tube: Red, blue, or green reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanent scale markings.

E. Window: Glass or plastic.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer. Brass for compatible services less than 353 degrees F; ANSI 18-8 stainless steel for all others to suit service. Furnish extension neck to accommodate insulation where applicable.

2.4 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Cambridge.
3. Dwyer Instruments, Inc.
4. Marsh Bellofram.
5. Miljoco Corporation.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Stainless steel, aluminum, or FRP, 6-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanent scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass or plastic.
8. Ring: Stainless steel or chrome plated metal.

C. Accuracy: Grade A, plus or minus 1 percent of middle half scale.

1. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
2. Water: 0-100 PSIG (1 psi divisions to 50 psi; 5 psi divisions above 50 psi), liquid filled.
3. Range for Fluids under Pressure: 1-1/2 times expected working pressure. If not a standard scale, select next largest scale.

D. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass ball type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 TEST PLUGS

A. Manufacturers:

1. Peterson Equipment Co., Inc.
2. Miljoco Corporation.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F for cold services, and 500 psig at 275 deg F for hot services.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be Neoprene.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be Nordel.

E. Test Kit: Furnish test kit(s) containing one pressure gage and adaptor, thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each thermal storage tank.
5. Outside-air, return-air, and mixed-air ducts.

B. Provide the following temperature ranges for thermometers:

1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 30 to 130 deg F, with 2-degree scale divisions].
3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages on inlet and outlet of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

D. Install ball valve and snubber fitting in piping for each pressure gage for fluids (except steam).

E. Install test plugs in tees in piping.

3.4 CONNECTIONS

A. Install gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.5 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 200519

SECTION 200529 - HANGERS AND SUPPORTS

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. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 20 Section “Mechanical General Requirements.”
3. Division 20 Section “Basic Mechanical Materials and Methods.”
4. Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
5. Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops" for pipe guides and anchors.
6. Division 21 Section "Fire-Suppression System" for pipe hangers for fire-protection piping.
7. Division 23 Section(s) "Metal Ducts"for duct hangers and support.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. MFMA: Metal Framing Manufacturers Association.

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Equipment supports.

1.6 QUALITY ASSURANCE

A. MSS Standards: Pipe hangers, supports, and accessories shall comply with the following:

1. MSS SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture, Selection, Application, and Installation.

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 HANGER ROD MATERIAL

A. Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575.

1. Rod continuously threaded.
2. Use of rod couplings is prohibited.

2.3 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article, and schedules and details on the Drawings for where to use specific hanger and support types.

1. Hangers and Supports for Fire Protection Piping: UL listed or FMG approved.

B. Manufacturers:

1. Anvil; ASC Engineered Solutions.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. Hilti USA.
5. nVent Electric plc; CADDY.
6. PHD Manufacturing, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.4 METAL INSULATION SHIELDS

A. Manufacturers:

1. Anvil; ASC Engineered Solutions.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. nVent Electric plc; CADDY.
5. PHD Manufacturing, Inc.

B. Description: MSS SP-58, Type 40, protective shields. Shields shall span an arc of 180 degrees.

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

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

2.5 PIPE COVERING PROTECTION SADDLES

A. Manufacturers:

1. Anvil; ASC Engineered Solutions.

2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. nVent Electric plc; CADDY.
5. PHD Manufacturing, Inc.

B. Description: MSS SP-58, Type 39A and Type 39B, for suspension of insulated hot pipe where heat losses are to be kept to a minimum.

1. Saddles shall match insulation thickness.
2. Saddle length: 12 inches.
3. Furnish with center rib for pipe sized NPS 12 and larger.

2.6 THERMAL-HANGER SHIELDS

A. Manufacturers:

1. American Mechanical Insulation Sales Inc. (AMIS).
2. B-Line by Eaton.
3. nVent Electric plc; CADDY.
4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

B. Description: Manufactured assembly consisting of insulation insert encased in 360 degree sheet metal shield.

1. Minimum Compressive Strength of Insert Material:

a. 100-psig- for sizes smaller than NPS 6.
b. 600-psig- for sizes NPS 6 and larger.

C. Insulation-Insert Material for Cold Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

F. Include carbon steel ASTM A36 load distribution plates as required by load, pipe movement, hanger style, and hanger spacing.

G. Thermal-Hanger Shields for Flexible Foamed Elastomeric Insulated Piping:

1. Manufacturer:

a. B-Line by Eaton/Armacell; Armafix IPH.
b. Aeroflex USA, Inc,; Aerofix-U.

c. ZSi-Foster, Inc.; Cush-A-Therm.

2. Insulation-Insert Material for Copper Piping with Flexible Foamed Elastomeric Insulation: Use the following:

a. Flexible foamed elastomeric, ASTM 534, Type I-Tubular Grade 1 with PUR/PIP support inserts.

H. Thermal-Hanger Shields for Small Diameter Piping:

1. Manufacturer:

a. Hydra-Zorb Company; Klo-Shure Insulation Couplings.

2. Insulation-Insert Material for Small Diameter Piping with Flexible Foamed Elastomeric or Glass Fiber Insulation: Use the following:

a. Rigid Hytrel thermoplastic insulation coupling designed for use with pipe or tube NPS 4 and smaller, and insulation from 3/8 inch to 1-1/2 inch thick.

2.7 ROOF MOUNTED PIPING SUPPORTS

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Low, Fixed-Height, Single-Base Stand: Assembly of base and horizontal member, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

a. B-Line by Eaton; Dura-Blok.
b. Eco Support Products.
c. MIFAB, Inc.; C-Port.
d. MIRO Industries; Conduit and Condensate Supports, and Rooftop Sleeper Support.
e. nVent Electric plc; CADDY.
f. Portable Pipe Hangers.

2. Base: Plastic, stainless steel, or recycled rubber.
3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.

C. Low, Adjustable-Height, Single-Base Stand: Assembly of base, horizontal member, and adjustable vertical members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

a. B-Line by Eaton; Dura-Blok.
b. Eco Support Products.
c. MIFAB, Inc.; C-Port.
d. MIRO Industries; Conduit and Condensate Supports.

e. nVent Electric plc; CADDY.
f. Portable Pipe Hangers.

2. Base: Plastic, stainless steel, or recycled rubber.
3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.
4. Vertical Members: Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575 with cadmium plated nuts and washers. Rod continuously threaded.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, 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 APPLICATIONS

A. Refer to application schedules on the Drawings.

B. For insulated pipe, oversize hanger elements to accommodate insulation thickness.

C. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

D. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.

E. Use hangers and supports with galvanized, metallic coatings for outdoor applications or where exposed to outdoor conditions.

F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. MSS Type 8 or spring type to meet system requirements.

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. Steel Frame Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Beam Clamps:

a. Center Loading: TYPE 21, 28, 29 and 30, unless otherwise indicated. Type 27 shall be allowed to support single pipes NPS 6 size or smaller only.
b. "C" Clamps: Type 19, 20 or 23, for supporting single pipes NPS 2-1/2 size or smaller only. Use of "C" clamps, or beam clamps of "C" pattern, or any modification thereof, is prohibited for supporting multiple pipes or pipes larger than NPS 2-1/2.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Use spring supports and sway braces TYPES 48, 49, 50, 51, 52, 53, 54, 55 or 56. For specific points:

a. Provide spring supports at point of support where vertical movement will occur.
b. For light loads and vertical movement less than 1/4 inch, TYPES 48 or 49 spring cushion supports.
c. For vertical movements in excess of 1/4 inch but less than 1/2 inch, TYPES 51, 52 or 53 variable spring supports shall be used, loaded to not more than 75 percent of published load rating.
d. For vertical movements of 1/2 inch and more, TYPES 54, 55 and 56 constant support spring hangers.
e. Sway braces; TYPE 50.
f. Variable spring hangers in accordance with referenced MSS Standards with "medium" allowable load change.

L. Comply with MSS SP-58 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structural frame.

B. Provide necessary piping and equipment supporting elements including: building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, other pipe, duct or equipment.

C. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohm meter to ensure proper isolation of dissimilar materials. Test shall be observed by the Owner's Representative and/or Architect.

D. Use copper plated or plastic coated supporting element in contact with copper tubing or glass piping.

E. File and paint cut ends and shop or field prime paint supporting element components.

F. Secure Type 40 shields to support elements in a manner that prevents movement and damage to insulation and jacket materials.

G. Hang piping parallel with the lines of the building, unless otherwise indicated. Route piping in an orderly manner and maintain gradient. Space piping and components so a threaded pipe fitting may be removed between adjacent pipes and so there will be not less than 1/2 inch of clear space between finished surfaces and piping. Arrange hangers on adjacent parallel service lines in line with each other.

H. Flange loads on connected equipment shall not exceed 75 percent of maximum allowed by equipment manufacturer. Flange loads in liquid containing systems shall be checked in the presence of the Architect when piping is full of liquid. No flange load is allowed on pumps, vibration isolated equipment or flexible connectors.

I. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.

J. Where necessary, brace piping and supports against reaction, sway and vibration.

K. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.

L. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.

M. Install hangers and supports for piping at intervals specified, at locations not more than 3 feet from the ends of each runout, not more than 3 feet from connections to equipment, and not over 25 percent of specified interval from each change in direction of piping and for concentrated loads such as valves, etc.

N. Base the load rating for pipe support elements on loads imposed by insulated weight of pipe filled with water. The span deflection shall not exceed slope gradient of pipe.

O. If structural steel, roofs, or tunnels will allow support spacing greater than that shown above, Contractor shall submit proposed support system along with structural calculations documenting the allowance of such spacing, in accordance with ANSI, B31.1, and MSS Guidelines.

P. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Support vertical risers at each floor penetration for piping in shafts or chases. Guide for lateral stability. Fit horizontal piping connected to moving risers with two spring supports connected adjacent to riser, spaced according to required hanger spacing.

Q. For risers at temperatures of 100 deg F or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.

R. After the piping systems have been installed, tested and placed in satisfactory operation, firmly tighten hanger rod nut and jam nut and upset threads to prevent movement of fasteners.

S. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.

T. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.

U. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.

V. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.

W. Building structure shall not be reinforced except as approved by the Architect in writing.

X. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.

Y. Roof-Mounting Pipe and Equipment Stand Installation:

1. Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Maintain support manufacturer’s recommended spacing.

Z. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

AA. Install hangers and supports to allow controlled thermal 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.

BB. Install lateral bracing with pipe hangers and supports to prevent swaying.

CC. 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.

DD. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

EE. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

FF. Refer to individual piping sections for hanger spacing and hanger rod sizes.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 PAINTING

A. Touch Up: 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 minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 200529

SECTION 200547 - MECHANICAL VIBRATION CONTROLS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 ACTION SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

1.3 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of these items is specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION EQUIPMENT BASES

A. **Type A**: Direct Isolator Attachment

1. Unit to be isolated is so constructed that vibration isolators of the type specified may be directly attached, provided that the edge deflection of the isolated unit base over unsupported span between mountings does not exceed specified or manufacturer's limits. If units to be isolated will not meet required deflection provisions, Type B bases shall be provided.

B. **Type B**: Factory-fabricated, welded, structural-steel bases or rails.

1. Structural Steel Bases:

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WF or a comparable product by one of the following:

1) Amber/Booth; a VMC Group Company.
2) Kinetics Noise Control, Inc.
3) Korfund Dynamics; a VMC Group Company.
4) Vibration Eliminator Co., Inc.
5) Vibration Isolation Co., Inc. (Pump Bases Only)
6) Vibration Mountings & Controls; a VMC Group Company.
7) Vibro-Acoustics.

b. 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. Include supports for suction and discharge elbows for pumps.
c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2. Structural-Steel Rails:

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ICS or a comparable product by one of the following:

1) Amber/Booth; a VMC Group Company.
2) Kinetics Noise Control, Inc.
3) Korfund Dynamics; a VMC Group Company.
4) Vibration Eliminator Co., Inc.
5) Vibration Isolation Co., Inc. (Pump Bases Only)
6) Vibration Mountings & Controls; a VMC Group Company.
7) Vibro-Acoustics.

b. 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. Include supports for suction and discharge elbows for pumps.
c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. **Type C** Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type BMK/KSL or a comparable product by one of the following:

a. Amber/Booth; a VMC Group Company.
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Isolation Co., Inc. (Pump Bases Only)
f. Vibration Mountings & Controls; a VMC Group Company.
g. Vibro-Acoustics.

2. 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. Include supports for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
5. 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.

2.2 VIBRATION ISOLATORS

A. **Type 1a** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type W, Super W, WSW, and WSWSW or comparable products by one of the following:

a. Amber/Booth; a VMC Group Company.
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.

2. Material: Standard neoprene for indoor applications.
3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.

B. **Type 1b** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, single layer, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and 1/4 inch steel load bearing plate. Factory cut to sizes that match requirements of supported equipment.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type Super WMSW and MBSW or a comparable product by one of the following:

    a. Amber/Booth; a VMC Group Company.
    b. Kinetics Noise Control, Inc.
    c. Korfund Dynamics; a VMC Group Company.
    d. Vibration Eliminator Co., Inc.
    e. Vibration Mountings & Controls; a VMC Group Company.
    f. Vibro-Acoustics.

2. Material: Standard neoprene for indoor applications.
3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.

C. **Type 2** Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ND or a comparable product by one of the following:

    a. Amber/Booth; a VMC Group Company.
    b. Kinetics Noise Control, Inc.
    c. Korfund Dynamics; a VMC Group Company.
    d. Vibration Eliminator Co., Inc.
    e. Vibration Mountings & Controls; a VMC Group Company.
    f. Vibro-Acoustics.

2. Durometer Rating: Selected for maximum possible static deflection with the loading of each piece of equipment.
3. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
4. Neoprene: Bridge-bearing neoprene as defined by AASHTO.

D. **Type 3** Spring Isolators: Freestanding, open-spring isolators.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type SLF or a comparable product by one of the following:

    a. Amber/Booth; a VMC Group Company.
    b. Kinetics Noise Control, Inc.
    c. Korfund Dynamics; a VMC Group Company.
    d. Vibration Eliminator Co., Inc.

e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. **Type 4** Restrained Spring Isolators: Restrained single and multiple spring mounts.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Types SLR and SLRS or comparable products by one of the following:

a. Amber/Booth; a VMC Group Company.
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.

2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.3 VIBRATION ISOLATION HANGERS

A. **Type 8a** Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type 30N or a comparable product by one of the following:

a. Amber/Booth; a VMC Group Company.
b. Kinetics Noise Control, Inc.
c. Korfund Dynamics; a VMC Group Company.
d. Vibration Eliminator Co., Inc.
e. Vibration Mountings & Controls; a VMC Group Company.
f. Vibro-Acoustics.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

B. **Type 8b** Spring Hangers with Vertical-Limit Stop: Precompressed combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type PC30N or a comparable product by one of the following:

    a. Amber/Booth; a VMC Group Company.
    b. Kinetics Noise Control, Inc.
    c. Korfund Dynamics; a VMC Group Company.
    d. Vibration Eliminator Co., Inc.
    e. Vibration Mountings & Controls; a VMC Group Company.
    f. Vibro-Acoustics.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 07 Section "Roof Accessories."

3.3 APPLICATION

A. Refer to Vibration Isolator Application Schedule on the drawings for isolator application and minimum deflection.

3.4 CONNECTIONS

A. Vibration isolate piping connected to vibration isolated equipment using Type 8a or 8b spring hangers, and with distance to be isolated as scheduled on the Drawings. Maximum spacing between isolators same as maximum distance between pipe hangers and supports.

B. Vibration isolate ductwork connected to air handling units, return air fans, and vibration isolated equipment using Type 8a or 8b spring hangers, and in accordance with isolation distances scheduled on the Drawings.

3.5 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.

1. Cast-in-place concrete materials and placement requirements are specified in Division 03.

B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. Isolator deflection.
2. Snubber minimum clearances.

3.7 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment 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.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's written recommendations.

3.8 CLEANING

A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION 200547

SECTION 200553 - MECHANICAL IDENTIFICATION

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. Division 20 Section “Mechanical General Requirements.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Samples: For color, letter style, and graphic representation required for each identification material and device.

B. Valve numbering scheme.

1.4 CLOSEOUT SUBMITTALS

A. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in Maintenance Manuals.

1.5 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME (ANSI) A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.6 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 location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:

1. Seton.
2. Brady.
3. EMED.
4. Craftmark.
5. Brimar Industries, Inc.
6. Marking Services Inc. (MSI).
7. Kolbi Pipe Marker Co.

2.2 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

    a. Manufacturer, product name, model number, and serial number.
    b. Capacity, operating and power characteristics, and essential data.
    c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME (ANSI) A13.1, unless otherwise indicated.
2. Type and Size of Letters: Comply with ANSI A13.1, unless otherwise indicated.
3. Legends: Spelled out in full or commonly used and accepted abbreviations.
4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

C. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

D. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, manufactured for direct burial service.

E. Detectable Underground Pipe Markers: Continuously printed plastic ribbon tape with detectable aluminum core and with colors meeting APWA requirements, not less than 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.4 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Vinyl, 2-inch minimum character height, with permanent pressure sensitive adhesive. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust).

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.

2. Valve-Tag Fasteners: Brass wire-link chain or beaded chain.

2.6 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size 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-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Finished hardwood or extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 20, 21, 22, and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

B. Area Served: Equipment serving different areas of a building other than where the equipment is installed shall be permanently marked in a manner that, in addition to identifying the equipment as specified in this Section, also identifies the area it serves.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.

2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, minimum 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed 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 through walls, floors, ceilings, and non-accessible 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 acoustical ceilings. Omit intermediately spaced markers.

C. Underground Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.

3.4 DUCT IDENTIFICATION

A. Identify ductwork with vinyl markers and flow direction arrows.

B. Locate markers at air handling units, each side of floor and wall penetrations, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:

a. Cold Water: Minimum 1-1/2 inches, round or square.
b. Hot Water: Minimum 1-1/2 inches, round or square.
c. Fire Protection: Minimum 1-1/2 inches, round or square.
d. Gas: Minimum 1-1/2 inches, round or square.

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

3.9 SCHEDULES

A. Paint colors are listed here for reference only. Painting is specified under Division 9.

PIPE LABELING AND COLOR CODING

Pipe System Label	Drawing Abbrev.	Labels	Piping
Sanitary Sewer	SAN	White on Green	Dark Brown
Sanitary Vent	V	White on Green	Dark Brown
Rain Conductor	RC	White on Green	Dark Brown
Acid Waste	AW	Black on Yellow	Black
Acid Vent	AV	Black on Yellow	Black
Domestic Cold Water	CW	White on Green	Light Green
High Pressure Domestic Cold Water	HPCW	White on Green	Light Green
Non-Potable Cold Water	NPCW	Black on Yellow	
Domestic Hot Water	HW	Black on Yellow	Dark Green
High Pressure Domestic Hot Water	HPHW	Black on Yellow	Dark Green
High Pressure Domestic Hot Water Return	HPHWR	Black on Yellow	Dark Green
Domestic Hot Water Return	HWR	Black on Yellow	Dark Green
Soft Cold Water	SCW	White on Green	Light Green
Soft Hot Water	SHW	White on Green	Dark Green
Soft Hot Water Return	SHWR	White on Green	Dark Green
Natural Gas	G	Black on Yellow	Yellow
Fuel Oil Supply	FOS	Black on Yellow	Yellow
Fuel Oil Return	FOR	Black on Yellow	Yellow
Compressed Air (90psig)	A(90psig)	Black on Yellow	Dark Blue
Compressed Air (25psig)	A	White on Green	Dark Blue
Laboratory Vacuum	LVAC	Black on Yellow	Unpainted
Carbon Dioxide	CO_2	Black on Yellow	Unpainted
High Purity Water	DI	White on Green	White
Hot Water Htg. Supply	HWHS	Black on Yellow	Dark Blue
Hot Water Htg. Return	HWHR	Black on Yellow	Dark Blue
Terminal Unit Heating Sup.	THS	Black on Yellow	Dark Blue
Terminal Unit Heating Ret.	THR	Black on Yellow	Dark Blue

Pipe System Label	Drawing Abbrev.	Labels	Piping
Animal Heating Supply	AHS	Black on Yellow	Dark Blue
Animal Heating Return	AHR	Black on Yellow	Dark Blue
Energy Recovery Loop Sup.	ERLS	Black on Yellow	Dark Blue
Energy Recovery Loop Ret.	ERLR	Black on Yellow	Dark Blue
Chilled Water Supply	CHWS	White on Green	Light Blue
Chilled Water Return	CHWR	White on Green	Light Blue
Condenser Water Supply	CWS	White on Green	Light Green
Condenser Water Return	CWR	White on Green	Light Green
Process Cooling Water Sup.	PCWS	White on Green	Light Green
Process Cooling Water Ret.	PCWR	White on Green	Light Green
Refrigerant Liquid	RL	Black on Yellow	
Refrigerant Suction	RS	Black on Yellow	
Steam Condensate	LPC	Black on Yellow	Aluminum
Medium Pressure Steam Condensate	MPC	Black on Yellow	Aluminum
High Pressure Steam Condensate	HPC	Black on Yellow	Aluminum
Pumped Steam Condensate	PC	Black on Yellow	Aluminum
Medium Pressure Steam (60 psig)	MPS	Black on Yellow	Aluminum
High Pressure Steam,	HPS	Black on Yellow	Aluminum
Low Pressure Steam (5 psig)	LPS	Black on Yellow	Aluminum
Fire Protection	FP	White on Red	Bright Red
Medical Gases	Refer to Division 22 Section “Medical Gas Systems.”		

SHEET METAL WORK

Service	Abbrev.	Labels	Ductwork
Air Conditioning Supply	Supply Air	White on Green	White
Air Conditioning Return	Return Air	White on Green	White
Exhaust Systems	Exhaust Air	Black on Yellow	Green
Outside Air Intake	Outside Air	White on Green	White
Mixed Air	Mixed Air	White on Green	White

PIPE LABELING AND COLOR CODING

Pipe System Label	Drawing Abbrev.	Labels	Pipe Color
Sanitary Sewer	SAN	Black on Green	Grey
Sanitary Vent	V	Black on Green	Grey
Rain Conductor	STORM	Black on Green	Black
Acid Waste	AW	Black on Yellow	
Acid Vent	AV	Black on Yellow	
Domestic Cold Water	CW	Black on Green	Dark Blue
Non-Potable Cold Water	NPCW	Brown	Dark Blue
Domestic Hot Water	HW	Black on Green	Light Blue
Domestic Hot Water Return	HWR	Black on Green	Light Blue
Natural Gas	G	Black on Yellow	Yellow
Compressed Air (90psig)	A(90psig)	Black on Yellow	Light Green
Compressed Air (25psig)	A	White on Green	Light Green
Laboratory Vacuum	LVAC	Black on Yellow	Brown
High Purity Water	DI	White on Green	
High Temperature Hot	HTHWS	Black on Green	Orange w/

Pipe System Label	Drawing Abbrev.	Labels	Pipe Color
Water Htg. Supply			Red Band
High Temperature Hot	HTHWR	Black on Green	Orange w/
Water Htg. Return			Red Band
Hot Water Heating Supply	HWHS	Black on Green	Orange
Hot Water Heating Return	HWHR	Black on Green	Orange
Terminal Unit Heating Sup.	TWHS	Black on Green	Orange
Terminal Unit Heating Ret.	TWHR	Black on Green	Orange
Perimeter Heating Supply	PWHS	Black on Green	Orange
Perimeter Heating Return	PWHR	Black on Green	Orange
Energy Recovery Loop Sup.	ERLS	Black on Yellow	
Energy Recovery Loop Ret.	ERLR	Black on Yellow	
Chilled Water Supply	CHWS	Black on Green	Dark Green
Chilled Water Return	CHWR	Black on Green	Dark Green
Condenser Water Supply	CWS	Black on Green	Brown
Condenser Water Return	CWR	Black on Green	Brown
Steam Condensate	LPC	Black on Yellow	Silver
Pumped Steam Condensate	PC	Black on Yellow	Silver
Low Pressure Steam	LPS	Black on Yellow	Silver
Fire Protection	FP	White on Red	Dark Red
Non-Painted Equipment	Match Piping	Match Piping	

SHEET METAL WORK

Service	Abbrev.	Labels	Ductwork
Air Conditioning Supply	Supply Air	White on Green	White
Air Conditioning Return	Return Air	White on Green	White
Exhaust Systems	Exhaust Air	Black on Yellow	Green
Outside Air Intake	Outside Air	White on Green	White
Mixed Air	Mixed Air	White on Green	White

END OF SECTION 200553

SECTION 200700 - MECHANICAL 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section “Hanger and Supports” for thermal hanger shield inserts.
4. Division 22 Section “Plumbing Fixtures: for protective shielding guards.
5. Division 23 Section "Metal Ducts" for duct liners.

1.2 SUMMARY

A. This Section includes mechanical insulation for pipe, duct, and equipment.

1.3 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. PVC: Polyvinyl Chloride.

D. SSL: Self-sealing lap.

1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

1.5 OUTDOOR, ABOVEGROUND PIPING INSULATION SYSTEMS DESCRIPTION

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

B. Fire-Suppression Piping Filled with Water:

1. All Pipe Sizes: Insulation shall be either of the following:

a. Flexible Elastomeric: 2 inches thick.
b. Glass-Fiber Pipe Insulation, Type I: 2 inches thick.

1.6 INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION

A. Acceptable indoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.7 FIELD-APPLIED JACKETING SYSTEMS DESCRIPTION

A. Acceptable field-applied jacketing materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe specialty.

1.8 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1. ESR Report: For fire-rated grease duct insulation.

1.9 QUALITY ASSURANCE

A. 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.

B. Ductwork Maximum Temperature Limits: Based on ASTM C 411 test procedures.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Prior to installation, protect insulation from exposure to water and from physical damage. Prior to installation, store insulation in manufacturer’s original packaging.

1.11 COORDINATION

A. Coordinate size and location of supports, hangers, and pre-insulated pipe shields/supports specified in Division 20 Section "Hangers and Supports."

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.

C. Coordinate installation and testing of heat tracing.

1.12 SCHEDULING

A. Schedule insulation application after pressure testing systems. 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, GENERAL REQUIREMENTS

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. Adhesives used shall be fire resistant in their dry states and UL listed.

2.2 PIPE INSULATION MATERIALS

A. Flexible Elastomeric: 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 products specified.

a. Aeroflex USA, Inc.; Aerocel Tube and Sheet.
b. Armacell LLC; AP Armaflex.
c. IK Insulation Group; K-Flex USA LLC; Insul-Tube and Insul-Sheet.

B. Glass-Fiber, Preformed Pipe Insulation, Type I:

1. Products: Subject to compliance with requirements, provide one of the products specified.

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

2. Type I, 850 deg F Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

2.3 DUCTWORK INSULATION MATERIALS

A. Blanket Insulation: 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: Subject to compliance with requirements, provide one of the products specified.

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite EQ.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap B.
e. Owens Corning; All-Service Duct Wrap.

B. Board Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. CertainTeed Corp.; Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

2.4 FIRE-RATED INSULATION SYSTEMS

A. Grease Duct Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested according to ASTM E2336.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Morgan Advanced Materials; Thermal Ceramics; FireMaster FastWrap XL and Pyroscat XL.
b. 3M Fire Protection Products; Fire Barrier Duct Wrap 615+.
c. Unifrax Corporation; FyreWrap Max 2.0.

2. Products: Subject to compliance with requirements, provide one of the products specified.

a. Morgan Advanced Materials; Thermal Ceramics; FireMaster FastWrap+.
b. 3M Fire Protection Products; Fire Barrier Duct Wrap 615+.
c. Unifrax Corporation; FyreWrap.

2.5 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, provide one of the products specified.

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.

2.6 ADHESIVES

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

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Aeroflex USA, Inc.; Aeroseal and Aeroseal LVOC.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.

C. 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, provide one of the products specified.

a. Childers Products, H.B. Fuller Company; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. Johns Manville Industrial Insulation; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the products specified.

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. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.

2.7 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Childers Products, H.B. Fuller Company; 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.

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.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the products specified.

   a. Childers Products, 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.

2.8 FACTORY-APPLIED JACKETS

A. Insulation systems 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. PSK Jacket: Metalized polypropylene, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as specified; roll stock ready for shop or field cutting and forming.

1. Products: Subject to compliance with requirements, provide one of the products specified.

   a. Airex Manufacturing, Inc.; E-Flex Guard.
   b. Johns Manville; Zeston and Ceel-Co.
   c. P.I.C. Plastics, Inc.; FG Series.
   d. Proto PVC Corporation; LoSmoke.
   e. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated tank heads and tank side panels.

C. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C, and including flexible glass fiber insulation inserts.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Airex Manufacturing, Inc.
b. Johns Manville; Zeston and Ceel-Co.
c. P.I.C. Plastics, Inc.; FG Series.
d. Proto PVC Corporation; LoSmoke.
e. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers:

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

D. Self-Adhesive Outdoor Jacket for Piping: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a fabric reinforced insulation cladding with natural aluminum stucco embossed facing.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. 3M VentureClad; 1579GCW-E.
b. Polyguard; Alumaguard.

2.10 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with rubber or acrylic adhesive; complying with ASTM C 1136 and UL listed.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 491 FSK or 791 Cold Seal Acrylic FSK, or comparable products by one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division.
b. 3M Venture Tape.

2. Width: 3 inches.
3. Thickness: 6 mils.
4. Adhesion (Rubber Adhesive): 100 ounces force/inch in width.
5. Adhesion (Acrylic Adhesive): 90 ounces force/inch in width.
6. Elongation: 3 percent.
7. Tensile Strength: 35 lbf/inch in width.
8. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 370 White PVC tape, or comparable products by one of the following:

    a. Avery Dennison Corporation, Specialty Tapes Division.
    b. 3M Venture Tape.

2. Width: 2 inches.
3. Thickness: 5 mils.
4. Adhesion: 20 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 15 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 488 AWF rubber adhesive or 788 Cold Seal acrylic adhesive, or comparable products by one of the following:

    a. Avery Dennison Corporation, Specialty Tapes Division.
    b. 3M Venture Tape.

2. Width: 3 inches.
3. Thickness: 3.0 to 4.0 mils.
4. Adhesion (Rubber Adhesive): 90 ounces force/inch in width.
5. Adhesion (Acrylic Adhesive): 50 ounces force/inch in width.
6. Elongation: 3 percent.
7. Tensile Strength: 14 to 20 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the products specified.

    a. PABCO-Childers Metals; Johns Manville Industrial Insulation; Pab-Bands and Fabstraps.
    b. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, provide one of the products specified.

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, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, provide one of the products specified.

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Inc.; Cupped Head.
4) Nelson Stud Welding; CHP.

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:

a. ACS Industries, Inc.
b. C & F Wire.
c. PABCO-Childers Metals; Johns Manville Industrial Insulation.
d. RPR Products, Inc.

2.12 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.

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.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

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 the 4 o'clock or 8 o'clock position on 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 as recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. For services with surface temperatures below ambient, install a continuous unbroken vapor barrier. 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 thermal hanger 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 thermal hanger 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 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 the 4 o'clock or 8 o'clock position on the 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 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. Where compression of insulation is possible, fabricate/install insulation per manufacturer's recommendations.

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. Manholes.
5. Handholes.
6. 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 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 through walls and partitions as detailed.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations:

1. Terminate ductwork insulation at angle closure of fire damper sleeves.
2. Install pipe insulation continuously through penetrations of fire-rated walls and partitions.

    a. Firestopping is specified in Division 07 Section “Through-Penetration Firestop Systems.”

E. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at angle closure of fire damper sleeves.
2. Pipe: Install insulation continuously through floor penetrations.

    a. Seal penetrations through fire-rated assemblies according to Division 07 Section "Through-Penetration Firestop Systems."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, 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 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.
9. Stencil or 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, vessels, and equipment. 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.

3.6 FLEXIBLE ELASTOMERIC PIPE INSULATION INSTALLATION

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 pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as 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.

3.7 GLASS-FIBER PIPE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but 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 PVC fitting covers when available.
2. When PVC fitting covers are not available, install preformed pipe insulation to outer diameter of pipe flange:

    a. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    b. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with fiberglass or mineral wool blanket insulation as specified for system.

3. 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 PVC fitting covers when available.
2. When PVC fitting covers 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 PVC fitting covers when available.
2. When PVC fitting covers are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 DUCT AND PLENUM INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.

1. 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 plenums.
    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.

2. 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 from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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 at 18-foot 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.

3. 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.
4. 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.
5. 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.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches 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, space 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 plenums.
    d. Do not over compress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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 at 18-foot 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.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-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.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

    1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where self-adhesive jackets are indicated, install according to manufacturer’s instructions and details on the drawings. Overlap seams arranged to shed water.

3.10 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, install two layers in strict accordance with manufacturer's instructions, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors in strict accordance with insulation manufacturer's to achieve same fire rating as duct.

C. Maintain a copy of insulation manufacturer's installation instructions on site for Code Official.

D. Where fire-rated plenum wrap system is indicated, secure to system piping to maintain a continuous UL-listed fire rating.

E. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Through-Penetration Firestop Systems."

3.11 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system specified in Division 09 painting Sections.

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.

END OF SECTION 200700

SECTION 202923 - VARIABLE FREQUENCY CONTROLLERS

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 work of this section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section “Motors.”

1.2 REFERENCES

A. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. ANSI/NEMA MG 1 - Motors and Generators.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. EMI: Electromagnetic interference.

C. LED: Light-emitting diode.

D. VFC: Variable frequency controller. Variable frequency controllers may also be referred to as variable speed drives, variable frequency drives, VSDs, or VFDs in other Specification Sections or on the Drawings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Indicating power, control and instrument wiring including ladder diagrams for field work as well as factory assembled work. Manufacturer's drawings are acceptable only when modified and supplemented to reflect project conditions. The drawings shall include:

1. Overall schematic (elementary) diagram in JIC form of the entire system of power and control circuitry. Indicate interfaces with control wiring by temperature controls contractor.
2. Wiring diagrams showing the wiring layout of component assemblies or systems.
3. Interconnection wiring diagrams showing terminations of interconnecting conductors between component assemblies, systems, control devices, and control panels complete with conductor identification, number of conductors, conductor and conduit size.
4. Sequence of operation for components, assemblies or systems.
5. Dimensional data.

B. Product Certificates: For each VFC from manufacturer.

C. Coordination Data for Motor-Driven Equipment: Accompanied by complete information concerning the respective motors including the following.

1. Principal dimensions.
2. Weights.
3. Horsepower.
4. Voltage, phase, frequency.
5. Speed.
6. Class of insulation.
7. Enclosure type.
8. Frame.
9. Bearings including ABMA Rating Life (L-10 basis).

10. Design letter.
11. Manufacturer.
12. Service Factor

D. Descriptive data shall include catalogues, guaranteed performance data with efficiency and power factor indicated at 75 percent and 100 percent of rated load and verification of conformance with other requirements of the Contract Documents. The information enumerated under NEMA MG1 Paragraph MG1-10.38, shall be arranged on one sheet for each motor.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Product Options for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items. Refer to Division 01 Section "Product Requirements."

C. 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.

D. Comply with NFPA 70.

E. Comply with IEEE 519 - Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store VFCs in permanently enclosed and conditioned spaces.

B. If stored in space that is not permanently enclosed and conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.9 COORDINATION

A. For Electrical Work Provided under Division 20, 22, and 23 Specifications: Furnish UL Listed components, in accordance with Division 26 Specifications and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.

B. Provide Electrical Work required for the operation of components and assemblies provided as part of the Work under Division 20, 22, and 23 Specifications.

C. Coordinate with temperature controls contractor for interfaces with temperature controls wiring.

D. Mount line voltage (120 VAC) control components specified as part of the Work under Division 20, 22, and 23 Specifications.

E. Refer to ELECTRICAL DRAWINGS and Division 26 Specifications for specified information regarding provisions for the arrangement of electrical circuits and components and for interface with Work specified under Division 20, 22, and 23 Specifications.

F. The mechanical contractor shall furnish and install the variable frequency controller. Electrical trades shall make power connections to both load and line side of the VFC.

1.10 WARRANTY

A. Warranty shall be 36 months from date of project acceptance. The warranty shall include all parts, labor, travel time and expenses.

PART 2 - PRODUCTS

2.1 GENERAL

A. Electrical Power Supply Characteristics:208 volts, 3 phase, 60 hertz (Hz).

B. Controller(s) shall be suitable for use with standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor. At any time in the future, it shall be possible to substitute standard motor (equivalent horsepower, voltage and RPM) in the field.

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. ABB Group.
2. Danfoss.
3. Eaton Corporation.
4. General Electric.
5. Hitachi America, Ltd.
6. Johnson Controls Incorporated (Private labeled ABB).
7. Mitsubishi Electric Automation, Inc.
8. Square D; Schneider Electric.
9. Toshiba International Corporation.
10. Yaskawa Electric America, Inc.

B. Provide variable frequency controllers as scheduled including coasting motor restart, and step over frequency.

1. The ratio of the total impedance to common system impedance shall be greater than or equal to 10.
2. The voltage notch area shall be limited to 16-400 volt microseconds.
3. The total harmonic disturbance (THD) as a result of voltage notching shall be 3 percent or less at the point of common coupling.
4. The THD as a result of current notching shall be 100 percent or less at the point of common coupling.

C. Provide 3 percent AC input line reactors sized appropriate for each current rating variable frequency controller.

D. Variable frequency controller (VFC) shall comply with all applicable provisions of the National Electrical Code.

E. Line side of the VFC shall have a displacement power factor of 0.95 or greater when motor is operating at 50 to 100 percent motor speed.

F. VFC shall have efficiency greater than 85 percent when motor is operating at 50 to 100 percent motor speed.

G. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

H. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 5 percent of VFC input voltage rating.
2. Input Frequency Tolerance: Plus 2 percent of VFC frequency rating.

I. Each variable frequency controller shall consist of an adjustable frequency converter which shall convert input power into an adjustable frequency output in an ambient temperature of zero to 40 deg C. Output power shall be suitable capacity and waveform to provide stepless speed control of the specified horsepower motor throughout the required speed range under variable torque load not exceeding the motor's full-load rating.

J. Provide fault detection and trip circuits to protect itself and the connected motor against line voltage transients, power line under voltage, output overvoltage and overcurrent. A disconnect with padlockable door interlocked external handle shall be supplied to disconnect the incoming power.

1. Minimum SCCR according to UL 508 shall be as indicated on the Drawings or 14,000 A, whichever is greater.

K. Minimum output frequency shall be the lowest frequency at which the connected motor can be operated without overheating.

L. Inverter shall contain current limiting circuitry, adjustable to 100 percent of motor full-load current to provide soft start, acceleration, and running without exceeding motor rated current. The current limit circuit shall be of the type for variable torque load, which acts to diminish output frequency while limiting, without directly causing shutdown.

M. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts. For safety, drive shall shut down and require manual reset and restart if automatic reset/restart function is not successful within three attempts.

N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Isolate signal circuits from the power circuits and design to accept a speed signal from a remote process controller in the automatic mode and from the speed control potentiometer in the manual mode. A door-mounted switch shall provide mode selection. The selected signal shall control the motor speed between the adjustable minimum and maximum speed settings. Maximum speed shall be field adjustable to 100 percent of rated speed. The speed signal shall follow a linear time ramp, adjustable from 4-20 seconds to provide acceleration from zero to minimum speed. When minimum speed is reached, the speed signal shall follow the linear time ramp for acceleration and deceleration control.

P. Mount the adjustable frequency inverter and other electrical components that provide the operation specified in a NEMA 1 enclosure. Equipment shall have external heat sinks, or air filters on all vents. The enclosure shall have hinged front access doors with latch. Cabinet to cabinet interconnecting wiring shall be factory dressed, tagged and harnessed, and shipped with one end attached.

Q. Controller shall have the ability to step-over certain set frequencies that may cause a system to resonate. The controller shall have at least two manually set points of frequency in which the controller shall step-over during operation.

R. Operating and monitoring devices for the inverter shall be door mounted and shall include the following:

1. Manual Speed Control to set speed in the hand (manual) mode.
2. Speed indicating meter, either in revolutions per minute, proportional to the applied frequency and voltage to indicate speed of the converter-powered motor or frequency (hertz).
3. VFC "fault/reset" pilot light pushbutton combination with dry contact for external alarm. Fault alarm shall not actuate upon normal shutdown.
4. Inverter "control power" indicator.
5. Motor "running" indicator and two dry contacts that close when motor is running.
6. Output current meter calibrated in "AC amps."
7. Operating selector switches and indicating light to perform the following functions:

    a. One hand-off-auto switch for the VFC with indicating lights (red-running, green-energized). In hand position, unit (VFC or bypass starter) shall start. In auto position, unit (VFC or bypass starter) shall start when remote dry contact is closed.
    b. Unit shall be capable of being padlocked in the off position.

8. Output voltmeter (0 - 600 VAC) (analog or digital).

S. The VFC is to be provided with isolated 4-20 mA DC output signals proportional to speed, current and voltage for connection by others.

T. The VFC shall be provided with the ability to communicate (monitoring) through RS485 connector.

U. Remote speed control shall be 4-20 mA control signal from a remote controller.

V. Variable frequency controller shall not cause motor to produce noise levels exceeding 80 dBA measured at a distance of 3 feet from the motor. If noise level of motor exceeds this amount, the contractor shall be responsible for correcting the problem.

W. Provide connection points for system safety controls such as smoke detectors, freeze stats, damper end switches, etc. as shown on mechanical temperature control drawings. Opening of a contact on safety controls wired to the drive shall shut down the motor(s).

X. Provide in each VFC, a relay, that upon loss of the automatic speed control signal shall:

1. Automatically set the motor rpm to half speed. This loss of signal relay shall be manually adjustable to be able to set default speed to some other value than half speed if required later in the field.

Y. Coordinate with the Temperature Controls Contractor for the interface of control wiring to the drive as required to meet the requirements of the temperature control drawings. Drive shall be furnished with internal control wiring configured in the factory to allow single connections of field wiring to terminal blocks in the drive by the Temperature Controls Contractor.

Z. All indicating lights shall be push to test or LED.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:

1. Power transistors, SCRs and diodes shall be tested to ensure correct function and highest reliability.
2. All printed circuit boards shall be tested at 50 deg C for 50 hours. The VFC manufacturer shall provide certification that the tests have been completed.
3. Every controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install and adjust materials and equipment in accordance with the manufacturer's instructions.

B. Obtain the manufacturer's instructions for materials and equipment provided under the Contract in detail necessary to comply with the requirements of the Contract Documents.

3.3 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. Upon completion of each installation, conduct complete acceptance tests in the presence of duly notified authorities having jurisdiction and the Owner to demonstrate component, assembly or system performance in accordance with the requirements of the Contract Documents.

C. In the event that a test demonstrates that a component assembly or system performance is deficient, the Owner may require additional tests after corrective work.

D. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

E. Component assembly and systems acceptance is predicated upon completion of specified work and receipt by the Owner of data specified under "Submittals."

F. Electrical testing of motors is specified in Division 20 Section “Motors.”

3.4 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set the taps on reduced-voltage autotransformer controllers.

C. Set field-adjustable circuit-breaker trip ranges.

D. Set field-adjustable pressure switches.

3.5 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.6 DEMONSTRATION

A. The VFC supplier/support group shall provide the following additional services:

1. On-site training of customer personnel in operation and maintenance of variable frequency controllers.
2. Provide four copies of a troubleshooting manual and factory training manuals to help the building operator determine what steps must be taken to correct any problem that may exist in the system.
3. Coordinate enrollment of customer personnel in factory-held service schools.

END OF SECTION 202923

SECTION 211100 - FIRE-SUPPRESSION SYSTEM

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. Provisions of Division 20 Section “Mechanical General Requirements” apply to this Section.

C. Related Sections include the following:

1. Division 10 Section "Fire-Protection Specialties" for cabinets and fire extinguishers.
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section "Hangers and Supports.”
4. Division 28 Section "Fire Alarm" for alarm devices not specified in this Section.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. PE: Polyethylene plastic.

C. Underground Service-Entrance Piping: Underground service piping below the building.

D. Hose Connection: Valve with threaded outlet matching fire hose coupling thread for attaching fire hose.

E. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13 and NFPA 14 for obtaining approval from authorities having jurisdiction.

1.3 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.4 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications, for bidding purposes, as follows:

a. Automobile Parking Areas: Ordinary Hazard, Group 1.
b. Building Service Areas: Ordinary Hazard, Group 1.
c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
d. General Storage Areas: Ordinary Hazard, Group 1.
e. Laundries: Ordinary Hazard, Group 1.
f. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
g. Office and Public Areas: Light Hazard.
h. Repair Garages: Ordinary Hazard, Group 2.
i. Residential Living Areas: Light Hazard.
j. Restaurant Service Areas: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm/sq. ft. over 1500-sq. ft. area.
d. Special Occupancy Hazard: As determined by authorities having jurisdiction.

4. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft.
b. Storage Areas: 130 sq. ft.
c. Mechanical Equipment Rooms: 130 sq. ft.
d. Electrical Equipment Rooms: 130 sq. ft.
e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.

D. Water velocity in the piping system shall not exceed the following:

1. Underground mains: 16 ft./sec.
2. Aboveground mains: 32 ft./sec.
3. Sprinkler branch lines: 24 ft./sec.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.6 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

B. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. Items penetrating finished ceiling include the following:

a. Lighting fixtures.
b. Air outlets and inlets.

D. Qualification Data: For qualified Installer.

E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, and the local offices of the Owner’s insurance underwriter including hydraulic calculations, if applicable.

1. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification number (SIN) or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

F. Fire-hydrant flow test report.

1.7 CLOSEOUT SUBMITTALS

A. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

B. Field quality-control reports.

C. Operation and Maintenance Data: For sprinkler specialties to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. The provisions and requirements of the NFPA and the Owner's insurance underwriter constitute mandatory minimum requirements for the work of this Section.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

D. Grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Coordinate with ceiling installer to ensure proper grid type and installation for use with flexible sprinkler drops.

1.10 EXTRA MATERIALS

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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

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 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, pressure class 350, with mechanical-joint bell end and plain end.

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 gland, rubber gasket, and steel bolts and nuts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, pressure class 350, with push-on-joint bell end and plain end.

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. Encasement for Underground Ductile-Iron Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.3 SCHEDULE 40 STANDARD-WEIGHT BLACK STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends, and with factory applied antimicrobial coating on inner wall of pipe.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865.

B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, and with factory applied antimicrobial coating on inner wall of pipe.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll- grooved ends, and with factory applied antimicrobial coating on inner wall of pipe.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil; Models 74FP and 7401; ASC Engineered Solutions.
2) Tyco Fire Protection Products by Johnson Controls Company; Grinnell G-Fire.
3) Victaulic Co. of America; Style 005H, 009N, 107N and 109.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys

matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.4 SCHEDULE 10 BLACK STEEL PIPE AND FITTINGS

A. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13 specified wall thickness in NPS 6 to NPS 10,and with factory applied antimicrobial coating on inner wall of pipe.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

B. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends, and with factory applied antimicrobial coating on inner wall of pipe.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil; Models 74FP and 7400; ASC Engineered Solutions.
2) Tyco Fire Protection Products by Johnson Controls Company; Grinnell G-Fire.
3) Victaulic Co. of America; Styles 005H, 009N, 107N, and 109.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.5 BACKFLOW PREVENTION DEVICES

A. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. FEBCO; a Division of Watts Water Technologies, Inc.
c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
d. Watts Water Technologies, Inc.; Watts Regulator Co.
e. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1047 and Factory Mutual Global (FMG) approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Size and Capacities: As scheduled on the drawings.

6. Body: Cast-iron or ductile-iron, with interior lining complying with AWWA C550 or that is FDA approved.
7. End Connections: Flanged.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:

    a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventor connection.
    c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

2.6 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 300-psig working-pressure rating if fittings are components of high-pressure piping system.

B. Sprinkler Drain and Alarm Test Fittings: Cast-bronze or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:

    a. Tyco Fire Protection Products by Johnson Controls Company.
    b. Fire-End and Croker Corp.
    c. Viking Corp.
    d. Victaulic Co. of America; Series UTD Universal Test and Drain.

C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Manufacturers:

    a. Elkhart Brass Mfg. Co., Inc.

D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Manufacturers:

    a. AGF Manufacturing Co.
    b. G/J Innovations, Inc.
    c. Triple R Specialty of Ajax, Inc.
    d. Tyco Fire Protection Products by Johnson Controls Company.

E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Manufacturers:

    a. CECA, LLC.

b. Merit.

F. Flexible Sprinkler Drop Fittings:

1. Manufacturers:

a. Victaulic Co. of America; VicFlex Sprinkler Fittings; AH-2 or AH2-CC with AB1 Bracket Assembly.
b. Reliable Automatic Sprinkler Co., Inc.; RASCOflex Series RFB.
c. FlexHead Industries, Inc.; ASC Engineered Solutions

2. Description: UL listed and FMG approved stainless steel flexible hose for connection to sprinkler, and with bracket for connection to commercial ceiling grid.
3. Standard: UL 2443.
4. Pressure Rating: 175 psig minimum; 300 psig if fittings are components of high-pressure piping system.
5. Size: Same as connected piping, for sprinkler.

G. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.7 LISTED FIRE-PROTECTION VALVES

A. Valves: UL listed or FMG approved.

1. Valves shall have 175-psig minimum pressure rating.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with operating wrench, extension rod, locking device, and cast-iron barrel.
3. Manufacturers:

a. McWane, Inc.; Kennedy Valve Div.
b. NIBCO.
c. Crane Co.; Crane Valve Group; Stockham Valves.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3: Ductile-iron body with grooved ends.
4. Manufacturers:

a. NIBCO.
b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.

1. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

    a. Manufacturers:

        1) McWane, Inc.; Kennedy Valve Div.
        2) Mueller Company; ASC Engineered Solutions.
        3) NIBCO.
        4) Tyco Fire Protection Products by Johnson Controls Company.
        5) Victaulic Co. of America; Series 705.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:

    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Crane Co.; Crane Valve Group; Stockham Valves.
    d. Hammond Valve.
    e. McWane, Inc.; Kennedy Valve Div.
    f. Mueller Company; ASC Engineered Solutions.
    g. NIBCO.
    h. Tyco Fire Protection Products by Johnson Controls.
    i. Victaulic Co. of America.
    j. Watts Water Technologies, Inc.; Watts Regulator Co.

F. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

    a. Manufacturers:

        1) Crane Co.; Crane Valve Group; Crane Valves.
        2) Hammond Valve.
        3) NIBCO.

2. NPS 2-1/2 and Larger: Cast or ductile -iron body with flanged or grooved ends.

    a. Manufacturers:

        1) McWane, Inc.; Clow Valve Co.
        2) Crane Co.; Crane Valve Group; Crane Valves.
        3) Crane Co.; Crane Valve Group; Jenkins Valves.
        4) Hammond Valve.
        5) Milwaukee Valve Company.
        6) Mueller Company.
        7) NIBCO.
        8) Victaulic Co. of America: Series 771.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, 2-circuit, supervisory switch.
2. NPS 2 and Smaller: Ball or butterfly valve with brass or bronze body and threaded or grooved ends.

    a. Manufacturers:

        1) Milwaukee Valve Company.
        2) NIBCO.
        3) Victaulic Co. of America; Series 728.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

    a. Manufacturers:

        1) Tyco Fire Protection Products by Johnson Controls.
        2) McWane, Inc.; Kennedy Valve Div.
        3) Milwaukee Valve Company.
        4) NIBCO.
        5) Victaulic Co. of America.

2.8 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.9 RISER MANIFOLD ASSEMBLIES

A. Contractor Option: Factory preassembled riser manifold assemblies may be used.

B. Available Sizes: NPS 1-1/4 to NPS 8.

C. Standard: UL listed and FMG approved.

D. Pressure Rating:

1. Standard-Pressure Valves: 175 psig minimum.

E. Assembly Includes:

1. Pressure Gages: Listed an approved as specified in this Section.

2. Waterflow Alarm Switch: Listed and approved vane type waterflow detector.
3. Inspector's Test and Drain Valve: As specified under Sprinkler Specialty Fittings in this Section.

F. Manufacturers:

1. Victaulic Co. of America; Series UM Universal Manifold Assembly.
2. Viking Corp.; EasyPac Commercial Riser Assemblies.

2.10 ALARM CHECK VALVES

A. General Requirements:

1. Standard: UL listed or FMG approved.
2. Pressure Rating:

a. Standard-Pressure Valves: 175 psig minimum.
b. High-Pressure Valves: 300 psig.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Manufacturers:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire Protection Products by Johnson Controls Company.
3. Viking Corp.
4. Victaulic Co. of America.

C. Description: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

1. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

2.11 AUTOMATIC (BALL DRIP) DRAIN VALVES

A. General:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

B. Manufacturer:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire Protection Products by Johnson Controls Company.

2.12 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 300-psig pressure rating if sprinklers are components of high-pressure piping system.

B. Manufacturers:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire Protection Products by Johnson Controls Company.
3. Victaulic Co. of America.
4. Viking Corp.

C. Automatic Sprinklers:

1. With heat-responsive glass bulb element complying with the following:

a. UL 199, for nonresidential applications.
b. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
c. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for 165 deg F "Ordinary" 212 deg F “Intermediate” temperature classification rating, unless otherwise indicated or required by application.

E. Sprinkler types, features, and options as follows:

1. Concealed ceiling sprinklers, including cover plate.
2. Extended-coverage sprinklers.
3. Pendent sprinklers.
4. Quick-response sprinklers.
5. Sidewall sprinklers.
6. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers. Escutcheons listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

1. Ceiling Mounting: Chrome-plated steel, 2 piece, with 3/4-inch vertical adjustment.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Sprinkler guards listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.13 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:

1. Elkhart Brass Mfg. Co., Inc.
2. Potter Roemer Fire Pro; A Member of Morris Group International.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

1. Type: Exposed, projecting, with two inlets and round escutcheon plate.
2. Type: Flush, with two inlets and square or rectangular escutcheon plate.
3. Finish: Polished chrome-plated.

2.14 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.

1. Manufacturers:

a. AFAC Inc.
b. Firematic Sprinkler Devices, Inc.
c. Reliable Automatic Sprinkler Co., Inc.
d. Tyco Fire Protection Products by Johnson Controls Company.
e. Viking Corp.

C. Electrically Operated Alarm: UL 464, with 6-inch- minimum- 8-inch- minimum- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.

1. Manufacturers:

a. Potter Electric Signal Company, LLC.
b. System Sensor.

D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:

a. Potter Electric Signal Company, LLC.
b. System Sensor.

E. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Manufacturers:

a. Potter Electric Signal Company, LLC.
b. System Sensor.

F. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:

a. Potter Electric Signal Company, LLC.
b. System Sensor.

G. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Manufacturers:

a. Potter Electric Signal Company, LLC.
b. System Sensor.

2.15 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge.
2. Ashcroft Inc.
3. Marsh Bellofram.
4. Viking Corp.
5. Weiss Instruments, Inc.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EARTHWORK

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING APPLICATIONS, GENERAL

A. Flanges, flanged fittings, unions, nipples, grooved-joint couplings, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

B. Underground Service-Entrance Piping: Ductile-iron, push-on or mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Wet-Pipe Sprinklers: Use the following:

Pipe Type	1 ½" & Smaller	2"	2 ½" – 3 ½"	4"	5" – 6"
Standard weight steel, threaded fittings	YES	YES	YES	YES	NO
Standard weight steel, grooved fittings	NO	NO	YES	YES	YES
Standard weight steel, welded fittings	NO	YES	YES	YES	YES
Schedule 10 steel, welded fittings	NO	YES	YES	YES	YES
Schedule 10 steel, grooved fittings	NO	NO	YES	YES	YES

3.6 VALVE APPLICATIONS

A. The following requirements apply:

1. Listed Fire-Protection Valves: UL listed or FMG approved for applications where required by NFPA 13.

a. Shutoff Duty: Use ball, butterfly, or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.

    a. Shutoff Duty: Use ball, butterfly, or gate valves.
    b. Throttling Duty: Use ball or globe valves.

3.7 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

C. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

D. Use of saddle style tees is not acceptable.

E. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. All grooved couplings, fittings, gaskets, valves, and specialties shall be the product of a single manufacturer.
2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

F. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Refer to Division 20 Section “Basic Mechanical Materials and Methods” for additional requirements.

3.8 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 33 Section "Water Distribution" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.9 PIPING INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints. Encase piping in corrosion-protective encasement.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install drain valves on standpipes.

J. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

K. Install alarm devices in piping systems.

L. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install sprinkler system piping according to NFPA 13, except use of “C” clamps, or beam clamps of “C” pattern, or any modification thereof, is prohibited for supporting pipes larger than NPS 2-1/2.
2. Refer to Division 20 Section “Hangers and Supports” for additional requirements.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

N. Fill wet-standpipe system piping with water.

O. Fill wet-pipe sprinkler system piping with water.

3.10 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

D. Specialty Valves:

1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.11 SPRINKLER APPLICATIONS

A. Use the following sprinkler types:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers Recessed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Sprinkler Finishes:

a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes; white polyester finish in natatoriums.
b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

5. Sprinkler Guards: For exposed sprinkler heads subject to damage.

3.12 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

C. Install sprinklers into flexible sprinkler drop fittings and install into bracket on ceiling grid. Install according to manufacturer's instructions and NFPA, State, and local guidelines. Ceiling grid must meet requirements of ASTM C 635 and C 636, coordinate with ceiling installer.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall.

B. Install ball drip valve at each check valve for fire department connection.

3.14 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

C. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

D. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

E. Electrical Connections: Power wiring and fire alarm wiring are specified in Division 26.

F. Connect alarm devices to fire alarm.

G. Ground equipment according to Division 26 Section "Grounding and Bonding."

H. Connect wiring according to Division 26 Section "Conductors and Cables."

I. 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.

3.15 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 20 Section "Mechanical Identification."

3.16 FIELD QUALITY CONTROL

A. 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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
5. Verify that equipment hose threads are same as local fire department equipment.
6. Test each backflow prevention device according to authorities having jurisdiction and the device's reference standard.

B. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

C. Verify that specified tests of piping are complete.

D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

F. Verify that potable-water supplies have correct types of backflow preventers.

G. Energize circuits to electrical equipment and devices.

H. Coordinate with fire alarm tests. Operate as required.

I. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.17 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

3.18 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

END OF SECTION 211100

SECTION 220523 - GENERAL-DUTY VALVES 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.

B. Related Sections include the following:

1. Division 20 Section "Mechanical Identification" for valve tags and charts.
2. Division 21 Fire-Suppression Piping for fire-protection valves.
3. Division 22 Piping Sections for specialty valves applicable to those Sections only.
4. Division 23 Section “General-Duty Valves for HVAC” for HVAC.
5. Division 23 Section "Temperature Controls" for control valves and actuators.

1.2 SUMMARY

A. This Section includes valves for general plumbing applications. Refer to piping Sections for specialty valve applications.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. NRS: Nonrising stem.
5. OS&Y: Outside screw and yoke.
6. PTFE: Polytetrafluoroethylene plastic.
7. RPTFE: Reinforced polytetrafluoroethylene plastic.
8. SWP: Steam working pressure.
9. TFE: Tetrafluoroethylene plastic.
10. WOG: Water, oil, and gas.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1. Certification that products for use in potable water systems comply with NSF 61 and NSF 372.

1.5 QUALITY ASSURANCE

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.6 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 angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block 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 handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

A. Isolation valves are scheduled on the Drawings. For other general plumbing valve applications, use the following:

1. Shutoff Service: Ball, butterfly valves.
2. Throttling Service: Angle, ball, butterfly, or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

D. For valves not indicated in the Application Schedules, select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
3. For Grooved-End Systems: Valve ends may be grooved.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted unless otherwise noted.

F. Wetted surfaces of valves contacted by consumable water shall contain not more than 0.25 percent weighted average lead content.

1. Exceptions:

a. Valves in pumped sanitary systems.
b. Valves in pumped storm systems.
c. Drain valves.
d. Valves in general air or vacuum systems.
e. Valves in irrigation systems.
f. Valves in non-potable water systems.
g. Valves in other plumbing systems not intended for human consumption.

G. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

H. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
3. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller.

I. Extended Valve Stems: On insulated valves.

J. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

K. Valve Grooved Ends: AWWA C606.

L. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.

M. Threaded: With threads according to ASME B1.20.1.

N. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Series 70LF-140/240.
b. Hammond Valve.
c. Kitz Corporation; Kitz Valves.
d. Milwaukee Valve Company; Model UPBA100S/150S.
e. NIBCO INC.; Models S-580-70-66-LF/T-580-70-66-LF.
f. Watts Water Technologies, Inc.

2.3 GENERAL SERVICE BUTTERFLY VALVES

A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.

2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD145.
b. Bray International, Inc.
c. DeZurik.
d. Emerson Automation Solutions; Keystone.
e. Forum Energy Technologies; ABZ Valve.
f. Hammond Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.; LD-2000-3/5.
i. Tyco Flow Control; Grinnell Flow Control.
j. Watts Water Technologies.

C. Grooved-End Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron body with grooved or shouldered ends and polyamide coating inside and outside; Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ASC Engineered Products.
b. NIBCO INC.; Model GD-4765-3/5.
c. Victaulic Co. of America.

2.4 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Model 162T-LF and 163T-LF (61YLF Series).
b. Milwaukee Valve Company; Model UP509/UP1509.
c. NIBCO INC.; Models S-413-B-LF or T-413-B-LF.
d. Watts Water Technologies; LFCVY/LFCVYS.

2.5 IRON SWING CHECK VALVES

A. Iron Swing Check Valves, General: MSS SP-71.

B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Model 910F.
b. Crane Co.; Crane Valves.
c. Crane Co.; Stockham Div.
d. Hammond Valve; IR1124-HI.
e. Milwaukee Valve Company; Model F-2974.
f. NIBCO INC.; Model F-918-B.
g. Watts Water Technologies.

C. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Mueller Co.
b. NIBCO, INC.; Model G-917-W.
c. Victaulic Co. of America.

2.6 LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Model CBV-LF (61LF Series).
b. Bonomi USA, Inc.; Series 100002 and 100003.
c. Hammond Valve; UP943 and UP947.
d. Milwaukee Valve Company; UP548T and UP1548T.
e. NIBCO INC.; Model S-480-Y-LF and T-480-Y-LF.
f. Watts Water Technologies; LF600.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 250 psig.
c. Body Design: Vertical flow.
d. Body Material: Lead free brass or bronze.
e. Ends: Threaded or Solder.
f. Disc: PTFE, TFE, or Polyethermide.

2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. NIBCO INC.; Model W-910-B-LF.
    b. Mueller Steam Specialty.
    c. Milwaukee Valve Company.
    d. Hammond Valve.

C. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. NIBCO INC.; Model F-910-B-LF.
    b. Mueller Steam Specialty.
    c. Milwaukee Valve Company.
    d. Hammond Valve.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Bronze ball valve as specified in this Section. Lead free construction is not required.
2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 CHAINWHEEL ACTUATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries, Inc.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Sprocket Rim with Chain Guides: Ductile iron , of type and size required for valve
2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
3. Chain: Hot-dip, galvanized steel.

2.10 SOURCE QUALITY CONTROL

A. Identification: Factory label or color coding to identify lead free valves.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 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.

END OF SECTION 220523

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods” for materials and methods common to mechanical piping systems.
3. Division 20 Section “Hangers and Supports.”
4. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
5. Division 22 Section “General-Duty Valves for Plumbing.”
6. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 SUMMARY

A. This Section includes domestic water piping inside the building.

B. Water meters will be furnished and installed by utility company.

1.3 PERFORMANCE REQUIREMENTS

A. Where not indicated on the Drawings, provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SYSTEMS DESCRIPTION

A. Potable and non-potable domestic water piping system materials are scheduled on the Drawing.

B. Under-Building-Slab, Water-Service Piping on Service Side of Water Meter: Refer to Division 22 Section “Facility Water Distribution.”

C. Refer to Application Schedules on the Drawings for valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use general service butterfly valves or cast-iron globe valves with flanged ends for piping NPS 2-1/2 and larger.
2. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
3. Drain Duty: Hose-end drain valves.
4. Isolation Valves at Domestic Water Meters: Gate Valves, NPS 2 and Smaller: Class 150, bronze.
5. Isolation Valves at Domestic Water Meters: Gate Valves, NPS 2-1/2 and Larger: Class 125, OS&Y, bronze-mounted cast iron.

D. Transition and special fittings with pressure ratings at least equal to piping rating may be used unless otherwise indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings .

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Fire-suppression-water piping.
2. Domestic water piping.
3. Compressed air piping.
4. HVAC hydronic piping.

1.7 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Water Samples: Specified in Part 3 "Cleaning" Article.

1.8 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

E. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

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. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

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

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. 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.

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

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. 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.

C. Grooved-Joint Systems:

1. Manufacturers:

    a. ASC Engineered Solutions; Gruvlok; Fig. 64 CTS SlideLOK.
    b. Victaulic Company; Style 606 and Style 607.

2. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
3. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

D. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Viega North America; ProPress System.
    b. NIBCO Inc.; Press System.
    c. Mueller Industries, Inc.; Streamline PRS.
    d. Elkhart Products Corporation; an Aalberts Industries Company; Xpress.
    e. Apollo Valves; by Conbraco Industries; ApolloXpress.
    f. ASC Engineered Solutions; Anvil Press.

2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Maximum 200-psig working-pressure rating at 250 deg F.

E. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube. Mechanically formed tee fittings may be used up to half size of main.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. T-DRILL Industries Inc.

2.4 VALVES

A. General-duty plumbing valves; and drain valves are specified in Division 22 Section "Plumbing Valves."

B. Balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."

2.5 SPECIALTY VALVES

A. Bronze Gate Valves: MSS SP-80, with malleable-iron handwheel.

1. Class 150, Rising-Stem, Bronze Gate Valves: ASTM B-62 bronze body, bonnet, and wedge, copper-silicone bronze stem, screw-in bonnet, threaded end connections; and having 300 psig CWP rating.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) Milwaukee Valve Company; Model 1150.
4) NIBCO INC.; Models T-131, S-134 or T-134.
5) Watts Water Technologies, Inc.; Series B-3110.

B. Cast-Iron Gate Valves: MSS SP-70, with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.

1. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim, and solid-wedge disc; and having 200 psig CWP rating.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) Milwaukee Valve Company; Model F-2885.
4) NIBCO INC.; Model F-617-O.
5) Watts Water Technologies.

2.6 WATER METERS

A. Refer to Division 20 Section “Mechanical General Requirements.”

B. Turbine-Type Water Meters: AWWA C701, totalization meter with 150-psig minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with the following end connections:

1. NPS 2 and Smaller: Threaded.
2. Manufacturers:

a. AALIANT; a Venture Measurement Product Line; Niagara.
b. Badger Meter, Inc.

c. Sensus Metering Systems Inc.

C. Remote Registration System: Direct-reading type complying with AWWA C706, or encoder-type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earthwork."

3.2 PIPING SYSTEM INSTALLATION

A. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Install under-building-slab copper tubing according to Copper Development Association's "Copper Tube Handbook." Joints under slab are not allowed. Install PVC sleeve where piping penetrates slab.

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 20 Section "Meters and Gages," and strainers are specified in Division 22 Section "Domestic Water Piping Specialties."

D. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops.

E. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves at low points in water mains, risers, and branches.
2. Install stop-and-waste drain valves where indicated.

F. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."

G. Install domestic water piping level without pitch and plumb.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.4 WATER METER INSTALLATION

A. Utility water meters will be furnished and installed by utility company.

B. System water meters shall be furnished and installed by the contractor.

C. Rough-in domestic water piping for water meter installation and install water meters according to utility company's requirements.

D. Install water meters according as follows.

1. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Division 20 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    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: MSS Type 49, spring cushion rolls, if indicated.

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

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for drawn-temper copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60-inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Soft copper tube: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.

H. Alternate support for copper tubing NPS 3/4 and smaller: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic water piping to distribution side of water meter with shutoff valve.

C. Connect domestic water piping to existing domestic water distribution piping. Use dielectric fitting if connection dissimilar metals. Refer to Application Schedule on the Drawings and Division 20 Section “Basic Mechanical Materials and Methods” for dielectric fittings.

D. Install piping adjacent to equipment and machines to allow service and maintenance.

E. Connect domestic water piping to the following:

1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
2. 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. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

3.7 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. 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:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. 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 separate report for each test, complete with diagram of portion of piping tested.
3. 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.
4. Cap and subject piping to static water pressure of 150 psig. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
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.

3.8 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 flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and plugs used 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.

3.9 CLEANING AND DISINFECTION

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

B. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as 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. 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.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
4. Division 22 Section "Domestic Water Piping " for water meters.
5. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
6. Division 22 Section "Drinking Fountains, Water Coolers and Cuspidors" for water filters for water coolers.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Flow Reports and Settings: For calibrated balancing valves.

C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
3. Comply with NSF 372, “Drinking Water System Components – Lead Content” for components with wetted surfaces in contact with potable water.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; Conbraco Industries, Inc.
b. FEBCO; a Division of Watts Water Technologies, Inc.
c. Watts Water Technologies, Inc.; Watts Regulator Co.
d. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; Conbraco Industries, Inc.
b. MIFAB, Inc.
c. Watts Water Technologies, Inc.; Watts Regulator Co.
d. Woodford Manufacturing Company.

2. Standard: ASSE 1011.
3. Body: Bronze or brass, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; Conbraco Industries, Inc.
b. FEBCO; a Division of Watts Water Technologies, Inc.
c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
d. Watts Water Technologies, Inc.; Watts Regulator Co.
e. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Size and Capacity: As indicated on the drawings.
6. Accessories:

a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; Conbraco Industries, Inc.
b. FEBCO; a Division of Watts Water Technologies, Inc.
c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
d. Watts Water Technologies, Inc.; Watts Regulator Co.
e. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Size and Capacities: As scheduled on the drawings.
6. Body: Bronze for NPS 2 and smaller; cast-iron or ductile-iron, with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:

a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
c. Y-Pattern strainer and soft-seated check valve.

2.3 BALANCING VALVES

A. Calibrated Balancing Valves NPS 1/2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong International, Inc.
b. Armstrong Pumps, Inc.
c. Apollo Valves; by Conbraco Industries, Inc.
d. Bell & Gossett; Xylem Inc.
e. Flo Fab Inc.
f. Flow Design Inc.
g. Griswold Controls.
h. NIBCO INC.
i. IMI Indoor Climate; Tour & Andersson.
j. Taco, Inc.
k. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Dezincification resistant brass, or bronze.
4. Minimum Flow Rate: 0.3 gpm.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Calibrated Balancing Valves NPS 3/4 to NPS 2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong International, Inc.

b. Armstrong Pumps, Inc.
c. Apollo Valves; by Conbraco Industries, Inc.
d. Bell & Gossett; Xylem Inc.
e. Flo Fab Inc.
f. Flow Design Inc.
g. Griswold Controls.
h. NIBCO INC.
i. IMI Indoor Climate; Tour & Andersson.
j. Taco, Inc.
k. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Dezincification resistant brass, or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Controls; Morris Group International; ST70.
b. Apollo Valves; Conbraco Industries, Inc.; Model MVD (34D Series).
c. Bradley Corporation.
d. Lawler Manufacturing Company, Inc.
e. Leonard Valve Company; Series 170-LF and 270-LF.
f. Watts Water Technologies, Inc.; Powers Division; Hydroguard Series LFe480, LFG480, and LFLM495.
g. Watts Water Technologies, Inc.; Watts Regulator Co.
h. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: 1/2-inch union or 3/8-inchcompression; with integral check valves.
7. Accessories: Adjustable temperature-control knob.
8. Outlet Temperature Range: Adjustable from 85 deg F to 120 deg F. Set at 105 deg F.
9. Minimum Flow Rate: 0.5 gpm.
10. Valve Finish: Rough bronze.

2.5 PREPIPED TEMPERED WATER MIXING SYSTEM

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Controls; Morris Group International.
b. Armstrong International, Inc. (RADA).

c. Bradley Corporation.
d. Lawler Manufacturing Company, Inc.
e. Leonard Valve Company.
f. Symmons Industries, Inc.
g. Watts Water Technologies, Inc.; Powers Division.
h. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Description: Completely assembled and tested pre-piped manifold system including mixing valve(s), recirculation pump, circuit setting balancing valve, aquastat, circulator switch box, thermometers, isolation valves, mounting strut, and test connection.
3. Standard: ASSE 1017.
4. Mixing Valve: Exposed-mounting, thermostatically controlled water mixing valve.

a. Material: Bronze body with corrosion-resistant interior components.
b. Connections: Threaded union inlets and outlet.
c. Accessories: Manual temperature control, check stops and strainers on hot- and cold-water supplies, and adjustable, temperature-control handle.
d. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
e. Size, Settings, and Capacities: As scheduled on the drawings.
f. Valve Finish: Rough bronze.

5. Pump: Meeting requirements in Division 22 Section “Domestic Water Circulation Pumps.”
6. Mounting Strut: Meeting requirements in Division 20 Section “Hangers and Supports.”

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers:

a. Apollo Valves; Conbraco Industries, Inc.
b. Keckley Company.
c. Metraflex Company.
d. Mueller Steam Specialty; a Watts Brand.
e. NIBCO, Inc.
f. Titan Flow Control, Inc.
g. Watts.
h. Yarway; Emerson Automation Solutions.

2. CWP: 200 psig minimum, unless otherwise indicated.
3. SWP: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
5. End Connections: Threaded or soldered for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Screen: Stainless steel with round perforations, unless otherwise indicated.
7. Perforation Size:

a. Strainers NPS 2 and Smaller: 0.033 inch.
b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.

8. Drain: Pipe plug.

2.7 OUTLET BOXES

A. Clothes Washer Outlet Boxes: WMSD-1

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Sioux Chief Manufacturing Company, Inc.; Ox Box.
    b. Oatey SCS.
    c. Guy Gray Manufacturing Co., Inc.

2. Mounting: Recessed.
3. Material and Finish: Enameled- or epoxy-painted-steel or Stainless-steel box and faceplate.
4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Outlet Boxes, OB-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Sioux Chief Manufacturing Company, Inc.; Ox Box.
    b. Oatey SCS.
    c. LSP Products Group, Inc.
    d. Acorn Engineering Company.

2. Mounting: Recessed.
3. Material and Finish: Enameled- or epoxy-painted-steel or Stainless-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.8 FIRE-RATED OUTLET BOXES

A. Fire-Rated Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Sioux Chief Manufacturing Company, Inc.; Ox Box.
    b. Oatey SCS; Fire-Rated Washing Machine Outlet Boxes.

2. Certification: Warnock Hersey certified for 1-hour and 2-hour fire-rated walls.
3. Mounting: Recessed. Using galvanized steel bracket.

4. Material and Finish: Bulk molded compound thermoset fire-rated plastic.
5. Faucets: Separate hot- and cold-water, 1/4-turn valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
6. Water Hammer Arrestors: Integral.
7. Drain: NPS 2 PVC tailpiece.
8. Drain Piece Metal Sleeve: Galvanized steel with integrated intumescent pad.
9. Box Pad: UL Classified Unifrax FyreWrap insulation material.

B. Fire-Rated Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Sioux Chief Manufacturing Company, Inc.; Ox Box.
   b. Oatey SCS; Fire-Rated Ice Maker Outlet Boxes.

2. Certification: Warnock Hersey certified for 1-hour and 2-hour fire-rated walls.
3. Mounting: Recessed. Using galvanized steel bracket.
4. Material and Finish: Bulk molded compound thermoset fire-rated plastic.
5. Faucet: Cold-water, 1/4-turn valved fittings.
6. Water Hammer Arrestors: Integral.
7. Box Pad: UL Classified Unifrax FyreWrap insulation material.

2.9 HOSE BIBBS

A. Hose Bibbs: HB-1

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants: WH-1

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Water Technologies, Inc.; Watts Regulator co.
f. Woodford Manufacturing Company.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.21.3M for self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover and lock.
9. Box and Cover Finish: Polished nickel bronze or chrome plated.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.

2.11 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (Copper Tube Type):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MIFAB, Inc.
b. PPP Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

B. Water Hammer Arresters (Metal Bellows Type):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Josam Company.
c. MIFAB, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.

f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Precharged stainless steel bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

C. Water Hammer Arresters (Custom Type):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Josam Company.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Type: Factory precharged stainless steel pressure chamber with stainless steel bellows and non-toxic hydraulic fluid having pressure gage and air valve with cap.
3. Size: Custom sized for application by manufacturer.

2.12 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.
4. Install strainer and soft-seated check valve upstream of backflow preventer. Exception: Fire protection backflow preventers.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated water mixing valves with strainers, and check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of each and pump.

F. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

G. Install water hammer arresters in water piping according to PDI-WH 201.

H. Install air vents at high points of water piping.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Calibrated balancing valves.

5. Primary, thermostatic, water mixing valves.
6. Outlet boxes.

B. 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 Division 20 Section "Mechanical Identification."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each backflow prevention device according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves as follows:

1. Set calibrated balancing valves at calculated presettings.
2. Measure flow each station and adjust where necessary.
3. Record settings and mark balancing devices.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 221123 - DOMESTIC WATER CIRCULATION 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

1.2 DEFINITIONS

A. PEI: Pump Energy Index as defined by the Department of Energy.

B. PEI_{CL}: Pump Energy Index – Constant Load, as defined by the Department of Energy.

C. PEI_{VL}: Pump Energy Index – Variable Load, as defined by the Department of Energy.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Department of Energy Requirements: Pumps supplied that are regulated by the Department of Energy pump standards shall bear the acceptable PEI index.

1. Constant load pumps supplied shall bear the acceptable PEI_{CL} index.
2. Variable load pumps supplied with variable speed controls shall bear the acceptable $PEIv_L$ index.
3. Submittals for approval shall clearly identify the applicable PEI index and affirm that that index meets the DOE pump standards.

D. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

F. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 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 rigging instructions for handling.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

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 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS (SMALL)

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Bell & Gossett; Xylem Inc.; Series PL.
3. Grundfos Pumps Corp.
4. Taco, Inc.; Series 1400.

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; and designed for installation with pump and motor shafts mounted horizontally.

1. Pump Construction: All bronze.

a. Casing: Radially split, bronze, with threaded companion-flange connections.
b. Impeller: Glass-reinforced corrosion-resistant material; keyed to shaft.
c. Shaft: High-strength alloy steel.
d. Seal: Mechanical, carbon/silicon carbide seal.
e. Bearings: Permanently oil-lubricated type.

2. Motor-Single speed, with oil-lubricated bearings, unless otherwise indicated; and directly mounted to pump casing. Comply with requirements in Division 20 Section “Motors.”

C. Capacities and Characteristics: Refer to Schedule on Drawings.

2.3 CONTROLS

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

1. Manufacturers:

a. Honeywell International, Inc.; Aquastat.
b. Johnson Controls, Inc.
c. Schneider Electric USA, Inc.
d. Siemens Industry, Inc.; Building Technologies Division.
e. White-Rodgers Div.; Emerson Electric Co.

2. Type: Strap-on sensor, with suitable removable spring clip attaching thermostat to hot-water circulation piping.
3. Range: 65 to 200 deg F.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac or 120 V, ac.
7. Settings: Start pump at 122 deg F and stop pump at 130 deg F.

2.4 FLEXIBLE CONNECTORS

A. Refer to Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

2.5 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of 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. Do not use pump motors as a support point.

D. Install centrifugal pumps with motor and pump shafts horizontal.

E. Install continuous-thread hanger rods and elastomeric hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 20 Section "Mechanical Vibration Controls." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 20 Section "Hangers and Supports."

3.3 CONTROL INSTALLATION

A. Install thermostats in hot-water return piping.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

    a. Close-coupled, horizontally mounted, in-line centrifugal pumps.
    b. Close-coupled, vertically mounted, in-line centrifugal pumps.

2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 20 Section "Valves" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 20 Section "Meters and Gages" for pressure gages and gage connectors.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. Connect thermostats to pumps that they control.

G. Interlock pump with water heater burner and time delay relay.

3.5 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 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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 221123

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements”.
2. Division 20 Section “Basic Mechanical Materials and Methods”.
3. Division 22 Section “Drainage Piping Specialties”.
4. Division 22 Section “Sanitary Waste and Vent Piping” for piping outside building.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

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

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

1.4 SYSTEMS DESCRIPTIONS

A. Sanitary waste and vent piping system materials are scheduled on the Drawing.

1.5 ACTION SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control inspection and test reports.

1.7 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).

C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

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 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers:

a. ANACO-Husky; McWane Plumbing Group.
b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
c. IDEAL-TRIDON.
d. MIFAB, Inc.
e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Tyler Pipe; McWane Plumbing Group.

2. Standards: CISPI 310.
3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

A. Hard Copper Tube: ASTM B 88, Types M, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Hard Copper Tube: ASTM B 88, Types L , water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: Schedule 40, ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.5 SPECIALTY PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, 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 Co.
e. NDS, Inc.
f. Plastic Oddities, Inc.

2. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe 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. Co.
b. Mission Rubber Co.

C. Rigid, Unshielded, Nonpressure Pipe 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.

D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Manufacturers:

    a. Cascade Waterworks Mfg. Co.
    b. Dresser, Inc.; DMD Div.
    c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
    d. JCM Industries, Inc.
    e. Smith-Blair, Inc.
    f. 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.

E. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

    a. SIGMA Corp.

2.6 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.

B. Form: Sheet or tube.

C. Color: Black or natural.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Comply with requirements in Division 31 Section “Earth Moving” for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM 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 coordination drawings.

B. Sanitary sewer piping outside the building is specified in Division 22 Section "Sanitary Sewerage."

C. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."

G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

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

1. Building Sanitary Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
2. Horizontal Sanitary Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
3. Vent Piping: 1/8-inch per foot down toward vertical fixture vent or toward vent stack.

K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

L. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

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

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 20 Section "Valves."

B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

    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.

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

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 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 drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage 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 drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section "Mechanical Identification."

3.9 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 drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

SECTION 221319 - DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section "Plumbing Fixtures" for hair interceptors.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For drainage piping specialties to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

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 size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CAST-IRON CLEANOUTS

A. Size: Cleanouts shall be same nominal size as the pipe they serve up to 4 inches. For pipes larger than 4 inches nominal size, minimum size of cleanout shall be 4 inches.

B. Exposed Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.; Series 58910.
b. MIFAB, Inc.; C1460.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; 4510 Series.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass or bronze plug with tapered threads.

C. Cast-Iron Floor Cleanouts (On-Grade Interior Floor Areas):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.; C1220-R.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4023S-F.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Spigot.
7. Closure: Brass, bronze, or plastic plug with tapered threads.
8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

D. Cast–Iron Floor Cleanouts (Not-On-Grade Interior Floor Areas):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.; C-1100-C-R-34.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4333C.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.

5. Clamping Device: Required.
6. Outlet Connection: Spigot.
7. Closure: Brass, bronze, or plastic plug with tapered threads.
8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

E. Cast-Iron Wall Cleanouts (Finished Wall Areas):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.; Model 58790-20.
    b. MIFAB,Inc.; C1460-RD.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded bronze or brass plug with tapered threads.
5. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains (Toilet Rooms, Labs, and Janitor's Closet) FD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Sioux Chief Manufacturing Company, Inc.; Finish Line Adjustable Drainage System.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2005Y-A.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products Inc.
    g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom unless otherwise noted.
8. Coating on Interior and Exposed Exterior Surfaces: Enamel.

9. Top or Strainer Material: Nickel bronze.
10. Top of Body and Strainer Finish: Nickel bronze.
11. Top Shape: Round, with vandal proof screws.
12. Dimensions of Top or Strainer: 7 inch diameter.
13. Top Loading Classification: Light Duty.
14. Inlet Fitting: Gray iron, with spigot outlet.
15. Trap Seal Protection Device: Required.

B. Cast-Iron Floor Drains (Mechanical Rooms, Electrical Rooms, and Penthouses) FD-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2142.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom unless otherwise noted.
8. Coating on Interior and Exposed Exterior Surfaces: Enamel.
9. Sediment Bucket: 3-3/4 inches deep, slotted sediment bucket with lift bar.
10. Top or Strainer Material: Cast-iron.
11. Top Shape: Round.
12. Dimensions of Top or Strainer: 11-1/2 inch diameter tractor grate, 29 square inches of free area. Provide partial grate where required to accept equipment drains.
13. Top Loading Classification: Heavy Duty.
14. Outlet Fitting: Gray iron, with spigot outlet.
15. Trap Seal Protection Device: Required.

2.3 TRENCH DRAINS

A. Modular Cast-Iron Trench Drains, TD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2810 Series.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3 for trench drains.

3. Material: Cast iron or ductile iron.
4. Flange: Anchor.
5. Clamping Device: Not required.
6. Outlet: Bottom unless otherwise indicated.
7. Grate Material: Cast iron.
8. Grate Finish: Not required.
9. Dimensions of Frame and Grate: 6 inches wide, and length indicated on Drawings.
10. Top Loading Classification: Heavy Duty.
11. Extension Sections: As required to suit project.
12. Trap Seal Protection Device: Required.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Acorn Engineering Company; Elmdor/Stoneman Div.
   b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly consisting of metal flashing collar and skirt extending at least **6 inches** from pipe, with boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Smith, Jay R. Mfg. Co.; Quad Close Trap Seal Device Fig. 2692.
   b. Rectorseal; a CSW Industrials Company; SureSeal Plus Inline Floor Drain Trap Sealer.

2. Standard: ASSE 1072-2007.
3. Sealing Element: Neoprene rubber or chemically resistant elastomer.
4. Size: 2 inch, 3 inch, 3-1/2 inch, or 4 inch.
5. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

2.6 ROOF DRAINS

A. Metal Roof Drains RD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.

b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 1015.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.4
3. Pattern: Roof drain.
4. Body Material: Cast iron.
5. Dimensions of Body: Minimum 10 inch diameter body.
6. Combination Flashing Ring and Gravel Stop: Required.
7. Flow-Control Weirs: Not required.
8. Outlet: Bottom unless otherwise noted.
9. Dome Material: Cast iron, or ductile iron.
10. Extension Collars: Required.
11. Underdeck Clamp: Required.
12. Sump Receiver: Required.

B. Metal Secondary Roof Drains ORD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 1074.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.4
3. Pattern: Roof drain.
4. Body Material: Cast iron.
5. Dimensions of Body: Minimum 10 inch diameter body.
6. Combination Flashing Ring and Gravel Stop: Required.
7. Flow-Control Weirs: Not required.
8. Outlet: Bottom unless otherwise noted.
9. Dome Material: Cast iron, or ductile iron.
10. Extension Collars: Required.
11. Underdeck Clamp: Required.
12. Sump Receiver: Required.
13. Standpipe: Cast iron. 2 inches high where overflow drains are indicated.

2.7 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Hub Outlets:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.

2. Size: Same as connected waste piping with increaser fitting of size indicated.

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. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

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 A112.21.2M.
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.

F. Downspout Boots, DSB-1:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout.

G. Downspout Covers, DNZ-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Fig. No. 1775.
   b. Zurn Plumbing Products Group; Specification Drainage Operation; Z199-DC.

2. Description: Round fabricated stainless steel frame with mounting holes, and with fabricated secured perforated stainless steel hinged strainer.
3. Size: Same as connected conductor.

2.8 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.9 OIL SEPARATORS

A. Oil Interceptors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Striem; OT-500

2. Type: Factory-fabricated interceptor for separating and removing light oil from wastewater.
3. Body Material: Polypropylene.
4. Interior Lining: Not required for polypropylene bodies.
5. Exterior Coating: Not required for polypropylene bodies.
6. Cleanout: Integral or field installed on outlet.
7. Manhole Extensions: Required.
8. Manhole Covers: Cast Iron, Extra heavy duty load rating required.
9. Mounting: Underground.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
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 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. 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.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.

2. Position roof drains for easy access and maintenance.

I. Assemble open drain fittings and install with top of hub 2 inches above floor.

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

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

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

M. Install manufactured, gray-iron downspout boots at grade with top 6 inches above grade. Secure to building wall.

N. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

O. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

P. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

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

R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

S. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

T. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Oil interceptors.

B. 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 Division 20 Section "Mechanical Identification."

3.5 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 221319

SECTION 221413 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section “Drainage Piping Specialties.”
4. Division 33 Section “Storm Utility Drainage Piping” for piping outside building.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

E. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:

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

1.4 SYSTEMS DESCRIPTIONS

A. Storm drainage piping system materials are scheduled on the Drawing.

1.5 ACTION SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.6 INFORMATIONAL SUBMITTALS

A. Shop Drawings:

1. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

1.7 CLOSEOUT SUBMITTALS

A. Field quality-control inspection and test reports.

1.8 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).

C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with “NSF-dwv” for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

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 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers:

a. ANACO-Husky; McWane Plumbing Group.
b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
c. IDEAL-TRIDON.
d. MIFAB, Inc.
e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Tyler Pipe; McWane Plumbing Group.

2. Standards: CISPI 310.
3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: Schedule 40, ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.4 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, 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 Co.
e. NDS, Inc.
f. Plastic Oddities, Inc.

2. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe 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. Co.
b. Mission Rubber Co.

C. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.; DMD Div.
c. EBAA Iron Sales, Inc.
d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
e. JCM Industries, Inc.
f. Romac Industries, Inc.
g. Smith-Blair, Inc.
h. 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.

D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

a. SIGMA Corp.

2.5 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.

B. Form: Sheet or tube.

C. Color: Black or natural.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Drainage."

B. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Drainage Piping Specialties."

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."

F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

G. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

H. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
2. Horizontal Storm-Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.

J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

K. Install underground PVC storm drainage piping according to ASTM D 2321.

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

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 20 Section "Valves."

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    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.

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

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

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.

3.7 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 according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. 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. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221413

SECTION 221513 - GENERAL-SERVICE COMPRESSED-AIR 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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section "Meters and Gages" for thermometers and pressure gages.
4. Division 22 Section "General-Service Compressed-Air Equipment" for compressed-air equipment and accessories.

1.2 SUMMARY

A. This Section includes piping and related specialties for general-service (shop) compressed-air systems operating at 200 psig and less.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.

C. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 125 psig and less.

D. NBR: Acrylonitrile-butadiene rubber.

1.4 SYSTEMS DESCRIPTIONS

A. Low-Pressure Compressed-Air Piping between Air Compressors and Receivers: Use the following piping materials for each size range:

1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

B. Low-Pressure Compressed-Air Distribution Piping: Use the following piping materials for each size range:

1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

C. Valves:

1. Refer to Division 20 Section "Valves" for general duty valves for compressed air service. Use metal valves, unless otherwise indicated.
2. Equipment Isolation NPS 2 and Smaller: Safety-exhaust ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pipes, tubes, and fittings.
2. Safety valves.
3. Pressure regulators.
4. Filters.
5. Automatic drain valves.
6. Quick couplings.
7. Hose assemblies.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For general-service compressed-air systems. Include relationship to other services that serve same work area.

1.7 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

1.8 QUALITY ASSURANCE

A. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.

B. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 1 "Systems Descriptions" Article for applications of pipe, tube, fittings, valves, and joining materials.

2.2 PIPES, TUBES, AND FITTINGS

A. Black, Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B.

1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
4. Wrought-Steel Fittings: ASME B16.9, Schedule 40, butt welding.
5. Forged-Steel Fittings: ASME B16.11, socket type.
6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.

B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Flexible Pipe Connectors: Refer to Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

2.3 JOINING MATERIALS

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.4 VALVES

A. General Duty Valves: Comply with requirements specified in Division 20 Section "Valves."

2.5 SPECIALTY VALVES

A. Safety-Exhaust, Bronze Ball Valves: Two-piece bronze stem and chrome-plated bronze ball, having exhaust vent opening for pneumatic applications, locking handle, threaded ends, and 600-psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Div.; 7K-100-27.
b. DynaQuip Controls.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.; Model T-585-70-SV.
f. Watts Water Technologies, Inc.

2.6 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Line Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Emerson Process Management; Fisher Controls.
b. IMI Norgren.
c. Parker-Hannifin Corporation.

2. Type: Diaphragm or pilot operated.

C. Air-Line Lubricators: Sizes and capacities indicated; equip with drip chamber and sight dome for observing oil drop entering airstream; with oil-feed adjustment screw and quick-release collar for easy bowl removal.

1. Provide with automatic feed device for supplying oil to lubricator.

D. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters in sizes and ratings indicated. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock.

E. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded.

F. Automatic Drain Valves: Corrosion-resistant metal body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

G. Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Aeroquip by Eaton.
    b. Hansen Coupling by Eaton.
    c. Parker Hannifin Corporation; Fluid Connectors Group; Quick Coupling Div.
    d. Snap-Tite; Division of Parker-Hannifin

2. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.

    a. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.

H. Hose-Reel Assemblies: Individual, retractable hose-reel units with steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and service hoses with adjustable ball stop and service connections matching hoses. Include 50 feet of delivery hose, 2 feet of connecting hose, and quick disconnect. Hose and fittings rated for minimum 125 psig service.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Reelcraft Industries.
    b. Hannay Reels Inc.

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSTALLATION

A. Drawings, plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.

C. Install air and drain piping with 1 percent slope downward in direction of airflow.

D. Install eccentric reducers where piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

E. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

F. Install flexible pipe connector on each connection to air compressors.

G. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver; install according to Division 20 Section "Meters and Gages."

3.2 VALVE INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping and valve installation.

B. Install metal general-duty valves according to Division 20 Section "Valves."

C. Install shutoff valve at each connection to and from general-service compressed-air specialties, equipment, and accessories. Install strainer if indicated.

D. Install check valves to maintain correct direction of fluid flow to and from compressed-air piping specialties and equipment.

E. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

F. Install automatic drain valves on intercoolers, aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

G. Install safety valves where recommended by specialty manufacturers.

3.3 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. 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 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.

C. Joining of Dissimilar Metal Piping: Use dielectric fittings. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for dielectric fitting types.

3.4 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 20 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    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.

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

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support horizontal piping within 12 inches of each fitting and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
3. NPS 1-1/2: 12 feet with 3/8-inch rod.
4. NPS 2: 13 feet with 3/8-inch rod.

G. Install supports for vertical, Schedule 40, steel piping every 15 feet.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to specialties and equipment to allow service and maintenance.

C. Connect piping to air compressors, accessories, and specialties with shutoff valve and union or flanged connection.

D. Use metal general-service compressed-air piping between air compressors and air receivers. Use of plastic piping for this application is prohibited.

E. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

F. Specialty and Equipment Flanged Connections: Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube.

3.6 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping systems. Refer to Division 20 Section "Mechanical Identification" for labeling and identification materials.

3.7 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Test and adjust piping safety controls. Replace damaged and malfunctioning safety controls.
2. Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

    a. Repair leaks and retest until no leaks exist.

3. Report results in writing.

END OF SECTION 221513

SECTION 221519 - GENERAL-SERVICE COMPRESSED-AIR 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section "General-Service Compressed-Air Piping" for compressed-air piping, valves, and related specialties.

1.2 SUMMARY

A. This Section includes general-service (shop) compressed-air equipment and related accessories.

1.3 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.

B. Standard Air: Free air at 68 deg F and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm.

C. PAO: Polyalphaolefin.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design compressed-air equipment mounting.

1.5 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following compressed-air equipment:

1. Air compressors, including receivers and intake filters.
2. Aftercoolers.
3. Compressed-air dryers.
4. Compressed-air filter assemblies.

1.6 INFORMATIONAL SUBMITTALS

A. Shop Drawings:

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: Power, signal, and control wiring.

B. Product Certificates: Certificates of shop inspection and data report for receiver tanks as required by ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Qualification Data: For Installer.

1.7 CLOSEOUT SUBMITTALS

A. Startup service reports.

B. Operation and Maintenance Data: For the following compressed-air equipment and accessories to include in emergency, operation, and maintenance manuals:

1. Air compressors.
2. Compressed-air dryers.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative of compressed-air equipment manufacturer for both installation and maintenance of units required for this Project.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of compressed-air equipment and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Fabricate and label receiver tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NFPA 70, "National Electrical Code."

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for concrete bases. Refer to Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 RECIPROCATING AIR COMPRESSORS

A. Pressure Lubricated, Reciprocating Air Compressors:

1. Manufacturers:

a. Pnuetech; PSB Series

2. General: Packaged air compressor and receiver consisting of compressor, motor, V-belt drive and totally enclosed belt guard all mounted on ASME air receiver, factory piped and wired between compressor controls and receiver.
3. Number of Compressors: One.
4. Compressor: Single acting, two stage, air-cooled reciprocating type. Cylinders constructed of gray cast iron, with deep cooling fins. Cylinders bolted to the crankcase for ease of maintenance and rebuild. Valve assemblies individually removable without removing the head and inlet or discharge piping. The compressor shall have hardened and lapped disc-type valves for continuous service. Two-piece connecting rods with cast in tubes for positive oil distribution to the piston pins, and having replaceable inserts and bushings. Low pressure pistons shall be aluminum with three automotive type compression rings and one automotive type oil ring. High pressure pistons shall be gray cast iron with three automotive type compression rings and one automotive oil ring. Connecting rod bearings shall be steel backed Babbitt lined automotive type. Crankshafts shall have integral counterweights and be rifle drilled for pressure lubrication to ensure positive oil distribution. Adjustable anti-friction tapered roller bearings shall be mounted on each end of the crankshaft to take both radial and thrust loads. Compressor flywheels dynamically balanced and of the fan type. Finned intercoolers shall be an integral part of all two stage units, and located in the direct blast of air from the fan type flywheel. Compressors equipped with a crankshaft driven oil pump located in the bearing carrier for easy removal and inspection. Include level oil filter located on the bearing carrier. Standard features include low oil protection and automatic loadless starting. Splash lubrication is not acceptable for this application.
5. Performance: Unit shall deliver scheduled CFM free air at 120 psig with ambient inlet conditions. The compressor must have a maximum working pressure of 200-psig.
6. Regulation: Dual Control - Combines auto start-stop with constant speed control. The unit can operate on auto start-stop when air demand is light or on constant speed control when air demand is heavy. Electropneumatic controls shall be incorporated with the control panel and the solenoid valve unloading.
7. Additional Equipment: Intake mufflers in conjunction with intake filter/silencers, vibration isolation pads as specified in Division 20 Section “Mechanical Vibration Controls.”
8. Beltguard: The compressor flywheel, motor flywheel and V-belts shall be totally enclosed within a metal belt guard providing protection on all sides in accordance to OSHA specifications.
9. Miscellaneous Devices: Safety valves, discharge-air pressure gages, pressure regulators, and shutoff valves.

2.3 AFTERCOOLERS

A. Aftercoolers, Air Cooled: Tubular; rated at 250 psig and leak tested at 350-psig minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F above summertime maximum ambient temperature.

1. Manufacturers:

a. Pnuetech; PSB Series

2.4 ACCESSORIES

A. General: Include accessories with working-pressure rating not less than system pressure at location where used, and compatible with equipment and piping system used.

B. Intercoolers: Air-cooled, fixed-bundle, tubular; rated at 250 psig and leak tested at 350-psig minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F above summertime maximum ambient temperature.

C. Separators: Conical-shaped, centrifugal air-line separator of capacity not less than connected equipment. Equip with water-removal trap and drain. Size units for maximum pressure drop through units of 3 psig from air inlet to outlet.

2.5 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Automatic Drain Valves: Mechanical-operation type with corrosion-resistant metal body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

C. Pressure Regulators: Bronze body, direct acting, spring loaded, manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.

1. Type: Diaphragm or pilot operated.
2. Manufacturers:

a. Emerson Process Management; Fisher Controls.
b. IMI Norgren.
c. Watts Fluid Air; Division of Parker-Hannifin.

D. Compressed-Air Filters:

1. Manufacturers:

a. Donaldson Filtration Solutions.
b. SPX Flow Technology; Dollinger.
c. SPX Flow Technology; Deltech.
d. Ultrafilter Inc.
e. Zeks Air Drier Corporation.

2. Mechanical-Separation Filters: Two-stage air-line filters of capacity not less than that of connected equipment. Equip with deflector plates; resin-impregnated-ribbon-type filters with edge filtration, 40 micrometers thick; and drain chock.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section "Motors."

1. 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.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases for compressed-air equipment. Concrete base is specified in Division 20 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 03.

3.2 EQUIPMENT INSTALLATION

A. Install air compressors on concrete bases. Install units level, plumb, and anchored to substrate in locations indicated. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing.

1. Anchor packaged equipment to concrete base.

a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
b. Install epoxy-coated anchor bolts for supported equipment; extend through concrete base and anchor into structural concrete floor.
c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
d. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Vibration Isolation: Mount equipment with motors larger than 5 hp on vibration isolation equipment base as specified in Division 20 Section "Mechanical Vibration Controls."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Install the following devices on compressed-air equipment:

1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.
3. Automatic Drain Valves: Install on intercoolers, aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect piping to air compressors and receivers, except safety relief valve connections, with flexible pipe connectors of materials suitable for service. Flexible pipe connectors and their installation are specified in Division 22 Section "General-Service Compressed-Air Piping."

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

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.

3.4 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for compressed-air equipment. Refer to Division 20 Section "Mechanical Identification" for labeling and identification materials.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to test, inspect, and adjust components and equipment installation and to perform startup service.

B. Perform the following final checks:

1. Verify that specified tests of piping systems are complete.
2. Verify that potable-water supply connections to equipment have correct backflow preventer.
3. Check for piping connection leaks.
4. Check for lubricating oil in lubricated-type equipment.
5. Check belt drives for proper tension.
6. Verify that air-compressor inlet filters and piping are clear.
7. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
8. Check safety valves for correct settings. Ensure that settings are greater than air-compressor discharge pressure but not greater than rating of system components.
9. Test operation of equipment safety controls and devices.
10. Drain receiver tanks.

C. Verify that compressed-air equipment is installed and connected according to the Contract Documents.

D. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in Division 26 Sections.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Complete installation and startup checks according to manufacturer's written instructions.

H. Prepare written report documenting testing procedures and results.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain general-service compressed-air equipment.

END OF SECTION 221519

SECTION 223410 - CONDENSING, FUEL-FIRED 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.

B. Related Section includes the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Breechings, Chimneys, and Stacks.”

1.2 DEFINITIONS

A. LP Gas: Liquefied-petroleum fuel gas.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Detail water heater assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection

1. Wiring Diagrams: Power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring.

B. Product Certificates: For each type of water heater, signed by product manufacturer.

C. Source quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For water heaters to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
3. Where ASME-code construction is indicated, fabricate and label commercial direct-fired storage water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV, HLW.

E. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:

1. ASHRAE 90.1, “Energy Efficient Design of New Buildings except Low-Rise Residential Buildings,” for commercial water heaters.
2. ASHRAE 90.2, “Energy Efficient Design of New Low-Rise Residential Buildings,” for household water heaters.

F. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

1.7 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

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 COMMERCIAL, GAS WATER HEATERS

A. Commercial, Circulating, High-Efficiency, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.

1. Manufacturers:

a. Lochinvar Corporation; Armor AWN Series with Lock-Temp Storage Tank.
b. Laars Heating Systems; a Subsidiary of Bradford White Corporation; Summit and Neotherm Series with Custom ASME Jacketed and Insulated Tank.
c. Smith, A. O. Water Products Company; XP Series with Custom ASME Jacketed and Insulated Tank.
d. Laars Heating Systems; a Subsidiary of Bradford White Corporation; Rheos+ Series with Custom ASME Jacketed and Insulated Tank.
e. Smith, A. O. Water Products Company; XP Plus Series with Custom ASME Jacketed and Insulated Tank.
f. Heat Transfer Products, Inc. (HTP); Elite Premier VWH, EXL VWH, and ModCon VWH.

2. Description: Manufacturer's proprietary design with boiler, storage tank, pump, piping, and controls to provide at least 95 percent thermal efficiency at optimum operating conditions. Following features and attributes may be modified or omitted if water heater otherwise complies with requirements for performance.
3. Boiler Construction: ASME code with 160-psig working-pressure rating for hot-water-boiler-type water heater.

a. Modulating, Condensing Heat Exchanger: Stainless steel, built to ASME Section IV requirements.
b. Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

4. Boiler Appurtenances:

    a. Insulation: Comply with ASHRAE/IESNA 90.1.
    b. Jacket: Steel with enameled finish.
    c. Burner: For use with finned-tube water heaters and for natural-gas fuel.
    d. Temperature Control: Adjustable, storage tank temperature-control fitting and flow switch, interlocked with circulator and burner.
    e. Safety Control: Automatic, high-temperature-limit cutoff device or system.
    f. Automatic Ignition: Intermittent electronic ignition complying with ANSI Z21.20.

5. Energy Management System Interface: Normally closed dry contacts for enabling and disabling water heater.
6. Support: Leveling legs, certified for installation on combustible floors.
7. Sealed Combustion/Direct Vent: Combustion air is ducted to the combustion chamber from the outdoors.
8. Hot-Water Storage Tank: Connected with piping to circulating pump and water heater.

    a. Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150-psig working-pressure rating.
    b. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

        1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
        2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

    c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
    e. Jacket: Steel with enameled finish.
    f. Anode Rods: Factory installed, magnesium.
    g. Drain Valve: Corrosion-resistant metal complying with ASSE 1005, factory installed.
    h. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

9. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig minimum working-pressure rating, and 225 deg F continuous-water-temperature rating.
10. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.
11. Capacity and Characteristics: Refer to Schedule on Drawings.

2.3 EXPANSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.

1. Manufacturers:

    a. AMTROL Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett; Xylem Inc. PT Series
    d. Taco, Inc.
    e. Wessels Co.

2. 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 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics: Refer to Schedule on Drawings.

2.4 WATER HEATER ACCESSORIES

A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.

B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.

C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

D. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.

    1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.

E. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.

    1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.

F. Drain Pans: Corrosion-resistant metal with raised edge. Provide dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

G. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

H. Flue Side Condensate Neutralizer:

    1. Description: Designed to raise the PH level of flue side condensate to near neutral prior to condensate entering the sanitary drainage system.
    2. Materials: Neutralizer constructed of PVC pipe and fittings mounted on channel strut base with galvanized or stainless steel clamps and hardware; and charged with calcium carbonate.

3. Manufacturers:

    a. Axiom Industries Ltd.; NeutraPal and NeutraPro Series.
    b. BKI Industries, Inc.; Acid Neutralizer Kits.
    c. J.J.M. Boiler Works; JM Neutralizing Tubes.
    d. Neutrasafe Corporation; Neutra-Safe Condensate Neutralizers.
    e. Any of the approved water heater manufacturers.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.

1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
2. Concrete base construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install gas water heaters according to NFPA 54.

D. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.

E. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

F. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.

G. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-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.

H. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-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.

I. 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 water heaters that do not have tank drains. Refer to Division 20 Section "Valves" for hose-end drain valves.

J. Install thermometer on outlet piping of water heaters. Refer to Division 20 Section "Meters and Gages" for thermometers.

K. Install pressure gages on inlet and outlet piping of commercial, fuel-fired water heater piping. Refer to Division 20 Section "Meters and Gages" for pressure gages.

L. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 20 Section "Valves" for general-duty valves and to Division 20 Section "Meters and Gages" for thermometers.

M. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

N. Fill water heaters with water.

O. Install expansion tanks with isolation and drain valves. Charge expansion tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Connect vent to full size of water heater flue outlet. Refer to Division 23 Section "Breechings, Chimneys, and Stacks" for venting materials.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

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, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water heaters.

END OF SECTION 223410

SECTION 224200 - PLUMBING FIXTURES

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. Division 10 Section "Toilet and Bath Accessories."
2. Division 20 Section “Mechanical General Requirements.”

3. Division 20 Section “Basic Mechanical Materials and Methods.”
4. Division 22 Section "Emergency Plumbing Fixtures."
5. Division 22 Section "Drinking Fountains and Water Coolers."
6. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers; individual-fixture, water tempering valves; and specialty fixtures not included in this Section.
7. Division 22 Section “Drainage Piping Specialties” for floor drains, and specialty fixtures not included in this Section.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

B. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and trim to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Comply with applicable ANSI, ASME, ASSE, ASTM, ICC, NSF, and UL standards and other requirements specified for plumbing fixtures, trim, fittings, components, and features.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

A. Water Closets, WC-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.; Madera FloWise 16-1/2” Elongated Toilet.
b. Kohler Co.; Highcliff Ultra K-96057.
c. Sloan Valve Company.
d. Zurn Plumbing Products Group.

2. Description: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.

    a. Style: Flushometer valve.

        1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
        2) Supply Spud Location: Top.
        3) Height: 16-1/2 to 16-3/4 inches, universal/accessible.
        4) Design Consumption: 1.28 gal./flush.
        5) Color: White.

    b. Flushometer: FV-2-1.
    c. Toilet Seat: TS-1.

B. Water Closets, WC-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Standard Companies, Inc.; Afwall Wall Hung Elongated Toilet.
    b. Ferguson Enterprises, Inc.; ProFlo.
    c. Kohler Co.; Kingston K-4325-0.
    d. Sloan Valve Company.
    e. Zurn Plumbing Products Group; EcoVantage.

2. Description: Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

    a. Style: Flushometer valve.

        1) Bowl Type: Elongated with siphon-jet design.
        2) Supply Spud Location: Rear.
        3) Design Consumption: 1.28 gal./flush.
        4) Color: White.

    b. Flushometer: FV-2-1.
    c. Toilet Seat: TS-1.
    d. Fixture Support: Water-closet support combination carrier.

2.2 MANUAL WATER CLOSET FLUSHOMETERS

A. Flushometers, FV-2-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Standard Companies, Inc.
    b. Delany Products.
    c. Delta Faucet Company.
    d. Kohler Co.: MACH Series.
    e. Sloan Valve Company.

f. Zurn Plumbing Products Group.

2. Description: Flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

a. Internal Design: Diaphragm or piston operation.
b. Style: Exposed.
c. Inlet Size: NPS 1.
d. Trip Mechanism: Oscillating, low-force ADA compliant lever-handle actuator.
e. Consumption: 1.28 gal./flush.
f. Tailpiece Size: NPS 1-1/2 and standard length to top of bowl.

2.3 TOILET SEATS

A. Toilet Seats, TS-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bemis Manufacturing Company; 1955SSC/1955SSCT.
b. Centoco Manufacturing Corp.
c. Church Seats; 295SSC/295SSCT.
d. Comfort Seats; a Jones Stephens Brand; Model Number C106SSC.
e. Ferguson Enterprises, Inc.; ProFlo PFTSCOF2000WH.
f. Olsonite Seat Company; Model 10SSC/10SSCT.
g. Plumbtech; Plumbing Technologies, LLC.
h. Sanderson Plumbing Products, Inc.; Beneke Div.
i. Zurn Plumbing Products Group; 5955STS-WH.

2. Description: Toilet seat for water-closet-type fixture.

a. Material: Molded, solid plastic.
b. Configuration: Open front without cover.
c. Size: Elongated.
d. Hinge Type: SC, self-sustaining, check.
e. Class: Standard commercial.
f. Color: White.

2.4 LAVATORIES

A. Lavatories, LAV-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kohler Co.; K 2005 Kingston.

2. Description: Accessible, wall-mounting, vitreous-china fixture.

a. Type: With contoured back and side shields.
b. Size: 21 1/4 by 18 1/8 inches rectangular.
c. Faucet Hole Punching: Three holes, 2-inch centers.
d. Color: White.
e. Faucet: LF-1.
f. Water Temperature Limiting Device: Required.
g. Drain: Grid or Grid with offset waste for accessible fixtures.
h. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, 17 gage tubular brass waste to wall; and wall escutcheon.

B. Lavatories, LAV-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kohler Co.; K-1997-8N.

2. Description: Accessible, wall-mounting, vitreous-china fixture.

a. Type: With contoured back and side shields.
b. Size: 21 15 /16 by 19 3/4 inches rectangular.
c. Faucet Hole Punching: 8” Widespread faucet holes.
d. Color: White.
e. Faucet: LF-2.
f. Water Temperature Limiting Device: Required.
g. Drain: Grid or Grid with offset waste for accessible fixtures.
h. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, 17 gage tubular brass waste to wall; and wall escutcheon.

2.5 LAVATORY FAUCETS

A. Lavatory Faucets, LF-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.; Heritage Model 5400.142H.
b. Chicago Faucets; Model 802V-317.
c. Delta Faucet Company; Model 21C132.
d. Kohler Co.; K7404-KE 1 K16010-5.
e. Moen Commercial.
f. Speakman Company; Model SC-3075.
g. T & S Brass and Bronze Works, Inc.
h. Zurn Plumbing Products Group; Z81104.

2. Description: Two-handle mixing faucet, vandal resistant, 2 holes, less grid strainer, and no lift rod hole.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Centers: 4 inches.

d. Mounting: Deck, concealed.
e. Valve Handle(s): Wrist blade, 4 inches.
f. Operation: Noncompression, manual.
g. Inlet(s): NPS 1/2.
h. Spout Outlet:

1) Vandal resistant aerator.
2) Laminar flow or plain end for patient care areas.

i. Maximum Flow Rate:

1) 0.5 gpm for faucets in public restrooms.

B. Lavatory Faucets, LF-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.
b. Chicago Faucets.
c. Delta Faucet Company.
d. Kohler Co.
e. Moen Commercial.
f. Speakman Company.
g. T & S Brass and Bronze Works, Inc.
h. Zurn Plumbing Products Group.; Z871G2-XL

2. Description: Two-handle mixing faucet, vandal resistant, 2 holes, less grid strainer, and no lift rod hole.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Centers: 8 inches.
d. Mounting: Deck, concealed.
e. Valve Handle(s): Wrist blade, 4 inches.
f. Operation: Noncompression, manual.
g. Inlet(s): NPS 1/2.
h. Spout Outlet:

1) Vandal resistant aerator.
2) Laminar flow or plain end for patient care areas.

i. Maximum Flow Rate:

1) 0.5 gpm for faucets in public restrooms.

2.6 COUNTER-MOUNTING SINKS

A. Sinks, SK-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Elkay Manufacturing Co. BLH15C
    b. Franke Consumer Products, Inc., Commercial Div.
    c. Just Manufacturing Company.
    d. Moen Commercial.

2. Description: Single-bowl, counter-mounting, lay-in stainless-steel sink and faucet kit.

    a. Overall Dimensions: 15 inches left to right by 15 inches front to back.
    b. Metal Thickness: 18 gage, with sound dampened underside.
    c. Bowl:

        1) Dimensions: 12 inches by 9 1/4 inches by 7 inches deep.
        2) Drain: 3-1/2-inch grid.

    d. Sink Faucet: Included
    e. Water Temperature Limiting Device: Not required.
    f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 17 gage tubular brass waste to wall; and wall escutcheon(s).
    g. Disposer: Not required.

B. Sinks, SK-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Moen Commercial.; GS181062B

2. Description: Single-bowl, counter-mounting, lay-in stainless-steel sink.

    a. Overall Dimensions: 33 inches left to right by 22 inches front to back.
    b. Metal Thickness: 18 gage, with sound dampened underside.
    c. Bowl:

        1) Dimensions: 29 7/8 inches by 16 1/2 inches by 9 inches deep.
        2) Drain: 3-1/2-inch outlet for disposer.

    d. Sink Faucet: SF-2
    e. Water Temperature Limiting Device: Not required.
    f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 17 gage tubular brass waste to wall; and wall escutcheon(s).
    g. Disposer: D-1.
    h. Dishwasher Air-Gap Fitting: Not required.

2.7 SERVICE SINKS

A. Service Sinks, SS-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.; Florwell Cast Iron Service Sink.
b. Kohler Co.; Whitby K 6710.
c. Zurn Plumbing Products Group; Z5850.

2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.

a. Size: 28 by 28 inches.
b. Color: White.
c. Faucet: Sink SF-3.
d. Drain: Grid with NPS 3 outlet.

B. Service Sinks, SS-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Regency; 600SMFSS23R.

2. Description: Floor-mounting, 304 Stainless Steel, mop sink with right side splash guard.

a. Size: 22 by 21 3/8 inches.
b. Color: White.
c. Faucet: PRU-3.
d. Drain: Grid with NPS 3 outlet.

2.8 COMMERCIAL SINKS

A. Commercial Sinks, CS-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkay Manufacturing Co.
b. Franke Consumer Products, Inc., Commercial Div.
c. Just Manufacturing Company.

2. Description: One-compartment, freestanding, Type 304 stainless-steel commercial sink with backsplash.

a. Overall Dimensions: 30 inches by 30 inches.
b. Metal Thickness: 14 gage.
c. Compartment:

1) Dimensions: 24 inches by 24 inches by 14 inches deep.
2) Drain: Grid with NPS 1-1/2 tailpiece.

a) Location: Centered in compartment.

d. Drainboard(s): Both left and right sides.
e. Supports: Tubular stainless steel legs with adjustable bullet shaped feet.
f. Faucet(s): Sink SF-1.

1) Mounting: In backsplash.

g. Drain Piping: chrome-plated, cast-brass P-trap; 17 gage tubular brass waste to wall; and wall escutcheon(s).

B. Commercial Sinks, CS-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Tabco.
b. Elkay Manufacturing Co.; 14-3C16X20-R-18X
c. Franke Consumer Products, Inc., Commercial Div.
d. Just Manufacturing Company.
e. Metal Masters Foodservice Equipment Co., Inc.

2. Description: Three-compartment, counter-mounting, stainless-steel commercial sink with backsplash.

a. Overall Dimensions: 72 1/2 left to right and 25 13/16 front to back.
b. Metal Thickness: 0.050 inch.
c. Each Compartment:

1) Dimensions: 18 inches by 20 inches by 14 inches deep.
2) Drains: Grid with NPS 2 tailpiece and twist drain.

a) Location: Centered in compartment.

d. Faucet(s): PRU-2.
e. Supplies: NPS 1/2 chrome-plated copper with stops or shutoff valves.
f. Drain Piping: NPS 2 chrome-plated, cast-brass P-trap; 0.045-inch- thick tubular brass waste to wall;and wall escutcheon(s).

2.9 SINK FAUCETS

A. Sink Faucets, SF-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.
b. Chicago Faucets; No. 631-R.
c. Delta Faucet Company; Model 28C4934-R2.
d. Elkay Manufacturing Co.; LK940GNO8T4H.
e. Kohler Co.; K7320-4.
f. Moen Commercial.
g. Speakman Company; SC-5749.
h. T & S Brass and Bronze Works, Inc.
i. Zurn Plumbing Products Group; Z842B4.

2. Description: Commercial/Industrial sink faucet. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

    a. Body Material: Commercial, solid brass.
    b. Finish: Polished chrome plate.
    c. Mixing Valve: Two handle.
    d. Centers: 8 inches.
    e. Mounting: Back/wall.
    f. Handle(s): Wrist blade, 4 inches.
    g. Operation: Noncompression, manual.
    h. Inlet(s): NPS 1/2.
    i. Spout Type: 70 to 120-degree restricted swing gooseneck.
    j. Spout Outlet: Aerator.
    k. Maximum Flow Rate:

        1) 1.5 gpm.

B. Sink Faucets, SF-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Delta Faucet Company; Model 9659-DST.

2. Description: Sink faucet. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

    a. Body Material: Commercial, solid brass.
    b. Finish: Polished chrome plate.
    c. Mixing Valve: Single handle.
    d. Centers: 4 inches.
    e. Mounting: Deck.
    f. Handle(s): Wrist blade, 4 inches.
    g. Operation: Noncompression, manual.
    h. Inlet(s): NPS 1/2.
    i. Spout Type: Two-function wand; Aerated stream or spray.
    j. Spout Outlet:

        1) Aerator.
        2) Laminar flow or plain end for patient care areas.

    k. Maximum Flow Rate:

        1) 1.5 gpm.

C. Sink Faucets, SF-3:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Standard Companies, Inc.
    b. Chicago Faucets; Model 897.

c. Delta Faucet Company; Model 28C2383.
d. Ferguson Enterprises, Inc.; ProFlo PF1118.
e. Kohler Co.
f. Moen Commercial.
g. Speakman Company; SC5811-RCP-LEV-5H-WHK.
h. Symmons Industries, Inc.
i. T & S Brass and Bronze Works, Inc.
j. Zurn Plumbing Products Group.

2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. Include 5 foot rubber hose and wall mounted hose clamp.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
d. Mixing Valve: Two handle.
e. Centers: 8 inches.
f. Mounting: Back/wall.
g. Handle(s): Lever.
h. Inlet(s): NPS 1/2.
i. Spout Type: Rigid, solid brass with wall brace and pail hook.
j. Spout Outlet: Hose thread.
k. Vacuum Breaker: Required.
l. Operation: Noncompression, manual.

2.10 SHOWER RECEPTORS

A. Shower Receptors, SH-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aker Plastics Co., Inc.
b. Americh.
c. Comfort Designs/Swan; a Division of the Praxis Companies, LLC.
d. Crane Plumbing, LLC; Fiat Products; an American Standard Brand.
e. Florestone Products Co., Inc.
f. Kohler Co.
g. LASCO Bathware.
h. Mustee, E. L. & Sons, Inc.
i. Sterling Plumbing Group, Inc.

2. Description: FRP base for built-up-type shower fixture.

a. Type: Standard, residential.
b. Size: 42 by 42 inches.
c. Color: White.
d. Outlet: Drain with NPS 2 outlet.

e. Faucet: SHF-1.

2.11 SHOWER FAUCETS

A. Shower Faucets: SHF-1

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Kohler Co.
f. Lawler Manufacturing Co., Inc.
g. Leonard Valve Company.
h. Moen Commercial.
i. Zurn Plumbing Products Group.; Z701-SS-LH

2. Description: Single-handle pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.

a. Body Material: Solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.
d. Mounting: Concealed.
e. Operation: Noncompression, manual.
f. Antiscald Device: ASSE 1016, integral with mixing valve.
g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
h. Supply Connections: NPS 1/2.
i. Shower Head Type: Ball joint.
j. Shower Head Material: Metallic with chrome-plated finish.
k. Integral Volume Control: Required.
l. Shower-Arm Flow-Control Fitting: Not required.
m. Temperature Indicator: Integral with faucet.

2.12 PRE-RINSE UNITS

A. Pre-Rinse Unit, PRU-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Zurn Plumbing Products Group; AquaSpec Z843X1

2. Description: Food service pre-rinse unit. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
d. Mixing Valve: Two handle.
e. Centers: Single hole.
f. Mounting: Deck.
g. Handle(s): Lever.
h. Inlet(s): NPS 1/2.
i. Riser: 23 inches with spring guide.
j. Hose: Flexible stainless steel, 44 inches, with insulated handle..
k. Spray Valve: Self closing.
l. Operation: Noncompression, manual.

B. Pre-Rinse Unit, PRU-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Zurn Plumbing Products Group; AquaSpec Z842P1-XL-PR1

2. Description: Food service pre-rinse unit. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
d. Mixing Valve: Two handle.
e. Centers: Single hole.
f. Mounting: Deck.
g. Handle(s): Lever.
h. Inlet(s): NPS 1/2.
i. Riser: 23 inches with spring guide.
j. Hose: Flexible stainless steel, 44 inches, with insulated handle.
k. Spray Valve: Self closing.
l. Operation: Noncompression, manual.

C. Pre-Rinse Unit, PRU-3:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Delta Faucet Company; 55C1583-S7.

2. Description: Food service pre-rinse unit. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
d. Mixing Valve: Two handle.
e. Centers: Single hole.
f. Mounting: Deck.

g. Handle(s): Lever.
h. Inlet(s): NPS 1/2.
i. Riser: 23 inches with spring guide.
j. Hose: Flexible stainless steel, 44 inches, with insulated handle.
k. Spray Valve: Self closing.
l. Operation: Noncompression, manual.

2.13 FIXTURE SUPPLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BrassCraft; a Masco Company.
2. McGuire Mfg. Co., Inc.
3. Any of the approved plumbing fixture manufacturers.

B. Description: Chrome-plated brass, loose-key or screwdriver angle stops with brass stems; rigid, chrome-plated copper risers; and chrome-plated wall flanges.

2.14 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers (PSG-1):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Engineered Brass Co.
b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
c. McGuire Manufacturing Co., Inc.
d. Oatey; Dearborn Safety Series.
e. Plumberex Specialty Products Inc.
f. TCI Products; SG-200BV.
g. TRUEBRO, Inc.
h. Zurn Plumbing Products Group; Z8946-3-NT.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.15 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water-Closet Supports:

1. Description: Combination carrier designed for wall-mounting, water-closet-type fixture. Include:

a. Single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement.
b. Faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture.
c. Cast iron nipple and coupling kit.
d. Additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Lavatory Supports:

1. Description: Lavatory carrier with concealed arms and tie rods for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

2.16 DISHWASHER AIR-GAP FITTINGS

A. Dishwasher Air-Gap Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B & K Industries, Inc.
b. Brass Craft Mfg. Co.; a Subsidiary of Masco Corporation.
c. Brasstech Inc.; Newport Brass Div.
d. Dearborn Brass; a div. of Moen, Inc.
e. Geberit Manufacturing, Inc.
f. JB Products; a Federal Process Corporation Company.
g. Sioux Chief Manufacturing Company, Inc.
h. Watts Brass & Tubular; a division of Watts Regulator Co.

2. Description: Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover; and capacity of at least 5 gpm; and inlet pressure of at least 5 psig at a temperature of at least 140 deg F. Include 5/8-inch- ID inlet and 7/8-inch- ID outlet hose connections.
3. Hoses: Rubber and suitable for temperature of at least 140 deg F.

a. Inlet Hose: 5/8-inch ID and 48 inches long.
b. Outlet Hose: 7/8-inch ID and 48 inches long.

2.17 DISPOSERS

A. Disposers, D-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. In-Sink-Erator; a div. of Emerson Electric Co.; 3/4 HP Badger 5 xp.

2. Description: Continuous-feed, household type food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; anti-splash guard; and combination cover/stopper. Include cord with grounded plug.

    a. Motor: 115-V ac, 1725 rpm, 3/4 hp with overload protection.

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 plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings. Install accessible fixtures at heights required by local codes.

H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Fixtures with flushometer valves, and faucets or valves with integral stops.

I. Install ASSE 1070 water-temperature limiting devices on supplies for lavatories and sinks that will be used for handwashing, and where specified. Refer to Division 20 Section “Domestic Water Piping Specialties.”

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install protective shielding guards PSG-1 on exposed traps and supplies of lavatories, and sinks used for hand washing.

M. Install toilet seats on water closets.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.

R. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

T. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.

U. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."

V. Set shower receptors and service basins in leveling bed of cement grout. Grout is specified in Division 20 Section "Basic Mechanical Materials and Methods."

W. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Individual water line branches, waste lines, vents, and traps for connection to individual fixtures, fixture fittings and specialties shall be in accordance with the schedule on the Drawings.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers and controls. Replace damaged and malfunctioning units **and controls**.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals, or cartridges of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224200

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers and water filters.
4. Division 22 Section "Drainage Piping Specialties" for floor drains and cleanouts.
5. Division 22 Section "Plumbing Fixtures" for laboratory faucets with integral eyewash.

1.2 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Tepid: Moderately warm.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. ASSE Standard: Comply with ASSE 1071 “Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment” for emergency mixing valves.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bradley Corporation: Halo S19224 Series.
b. Chicago Faucets.
c. Encon Safety Products.
d. Guardian Equipment Co.
e. Haws Corporation.
f. Sellstrom Manufacturing Co.

g. Speakman Company; Optimus SE-1050.
h. Stingray Systems.

2. Description: Plumbed, accessible, wall-mounting eye/face wash equipment with receptor and wall bracket.

a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Receptor: Stainless-steel bowl.
e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

2.2 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment, MV-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Controls; Morris Group International; ET71 Series.
b. Armstrong International, Inc. (RADA)
c. Bradley Corporation.
d. Guardian Equipment Co.
e. Haws Corporation.
f. Lawler Manufacturing Co., Inc.; Model 911 E.
g. Leonard Valve Company.
h. Powers, a Watts Industries Co.; Model ES 200.
i. Speakman Company.
j. Stingray Systems; SV125.

2. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at a single emergency eye/face wash and drench shower unit, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

2.3 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General Duty Valves for Plumbing."

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency plumbing fixture.
2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 20 Section "Basic Mechanical Materials and Methods."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 20 Section "Meters and Gages."

G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.

H. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Drainage piping is specified in Division 22 Section "Sanitary Waste and Vent Piping."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."

J. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 20 Section "Mechanical Identification."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

B. Electrical-Component Testing: After electrical circuitry has been energized, test for compliance with requirements.

1. Test and adjust controls and safeties.

C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

D. Report test results in writing.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 224500

SECTION 224700 - DRINKING FOUNTAINS, WATER COOLERS, AND CUSPIDORS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS

A. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler.

F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.

G. TDS: Total dissolved solids.

H. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.3 ACTION SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

C. Regulatory Requirements: Comply with requirements in the U.S. Architectural & Transportation Barriers Compliance Board’s “Uniform Federal Accessibility Standards (UFAS), 1985-494-187” about fixtures for people with disabilities.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

E. AHRI Standard: Comply with AHRI's "Directory of Certified Drinking Water Coolers" for style classifications.

F. AHRI Standard: Comply with AHRI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with AHRI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

G. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE (ELECTRIC) WATER COOLERS

A. Water Coolers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkay Manufacturing Co.; EZS8WS.
b. Halsey Taylor.
c. Haws Corporation.
d. Murdock Manufacturing; A Member of Morris Group International.
e. Oasis Corporation.
f. Sunroc Corp.

2. Description: Accessible, AHRI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult-mounting height, with bottle filling station.

a. Cabinet: Single, steel with powder-coat-finish and stainless-steel top; or vinyl-covered steel with stainless-steel top.
b. Bubbler: One, flexible or elastomeric overmolded, with adjustable stream regulator, located on each cabinet deck.
c. Control: Push bar.
d. Supply: NPS 3/8 with isolation valve.
e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
g. 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.

1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
2) Electrical Characteristics: 1/5 hp; 120-V ac; single phase; 60 Hz.

h. Bottle Filling Station: Recessed design constructed of 18 gage Type 300 series stainless steel and ABS plastic. Include:

1) Electronic sensor for no-touch activation.
2) Automatic 20-second shut-off timer.
3) 1.1 gpm flow rate
4) Anti-microbial protected plastic components.

i. Support: Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.; A Member of Morris Group International.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, 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.

END OF SECTION 224700

SECTION 230500 - 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Testing, Adjusting, and Balancing.”

1.2 SUMMARY

A. This Section includes common requirements for fans and air moving equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Fan bearings.
2. V-belt fan drives.
3. Direct drive couplings.

1.4 QUALITY ASSURANCE

A. 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.

B. Fan Performance Data: AMCA Standard 210.

C. Sound Power Level Ratings:

1. Ducted Fans - Rated per AMCA 301, when tested per AMCA 300.
2. Nonducted Fans - Rated in Zones at 5 feet from acoustic center of fan rated per AMCA 301, tested per AMCA 300 and converted per AMCA 302.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 FAN SHAFTS

A. Fan Shafts: Ground from solid cold rolled steel, and proportioned to run at least 25 percent below the first critical speed.

2.3 FAN POWER TRANSMISSION

A. V-Belt Type Fan Drives: In accordance with Engineering Standard Specification for Drives Using Multiple V-Belts, sponsored by the Mechanical Power Transmission Association and the Rubber Manufacturer's Association.

B. A given manufacturer's V-belt drive, as applied to specific equipment provided under the Contract, shall conform to the equipment manufacturer's published recommendations, except as otherwise specified.

C. Base horsepower rating of drive on minimum pitch diameter of small sheave.

D. Locate belt drives outboard of bearings. Align drive and driven shafts by the four-point method.

E. Adjust belt tension in accordance with the manufacturer's recommendations.

F. Perform alignment and final belt tensioning in the presence of the Architect.

2.4 SHEAVES

A. Furnish sheaves of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.

B. For all constant speed fans at or above 2 inches of total static pressure, Contractor shall provide and install two sets of fixed sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after system balance is complete and shall be based on actual field conditions.

C. For all constant speed fans below 2 inches total static pressure, Contractor shall provide and install two sets of adjustable sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after the balance is complete and shall be based on actual field conditions, and selected at mid-range of the sheave.

D. Set pitch diameters of fixed pitch and adjustable or variable pitch sheaves when adjusted as specified, at not less than that recommended by NEMA Standard MG1-14.42.

E. For companion sheaves for adjustable or variable pitch drives, furnish wide groove spacing to match driving sheaves.

F. For all variable frequency controller (VFC) operated fans, contractor shall provide and install one set of fixed sheaves sized to allow full utilization of fan motor horsepower provided, with VFC at 100 percent of fan motor RPM.

2.5 V-BELT FAN DRIVES

A. Fan Drives: Multiple V-belt style with adjustable pitch driver sheaves for fans up to 2 inches of total static pressure and fixed pitch driver sheaves for fans at or above 2 inches of total static pressure and up. Sheaves shall have split, taper style bushings. Drives shall be selected for a 150 percent service factor and shall provide for adjustment of both belt tension and alignment.

B. Manufacturers:

1. Emerson Power Transmission; Browning.
2. Rockwell Automation; Dodge.
3. T.B. Wood's Incorporated.

2.6 FAN DRIVE, SHAFT, AND COUPLING GUARDS

A. Safety Provisions: Include guards and screens for power transmission equipment, but do not negate vibration isolation provision.

B. Furnish ANSI and OSHA compliant mechanical power transmission apparatus guards except where superseded by other governing codes, and except as modified and supplemented. Requirements specified apply to all types of fans.

C. Fabricate mechanical power transmission device guards such that the completed structure is capable of withstanding a load of at least 200 pounds applied in any direction.

D. Furnish a guard enclosure for each V-belt drive, coupling, shaft, and rotating component. Secure guards in place, easily removable for maintenance. Guard fasteners used for maintenance access shall be "captive type." Locate holes on each guard for tachometer readings on both the motor and fan shafts. Fabricate guard of minimum 16 gage sheet metal with hemmed edges at openings for shafts. Weld four mounting lugs or feet of 10 gage material to the guard. Fabricate guards for couplings five inches in diameter and larger of 12 gage sheet metal. Furnish holes in mounting feet sized for suitable machine screws.

E. Centrifugal exhaust fans shall be provided with shaft seals.

2.7 BELT DRIVE GUARDS

A. Belt Guards: ANSI and OSHA compliant with provision for readily viewing belt tension and measuring shaft speeds. Guards shall be installed with quick release pins, so that removal of three to five clip pins, will allow the guard to be removed from fan housing.

B. Fabricate guards which completely enclose moving parts of the particular drive. Design and construct guards of such rigidity as to contain a belt which breaks during operation. Minimum material thickness, 16 gage sheet metal. Where ventilation is required, perforated metal shall be used for the sides. Fabricate top of solid sheet metal.

2.8 V-BELTS

A. Notched or cogged style, endless type, of Dacron reinforced elastomer construction, with cross-section to suit sheave grooves. Determine the number of V-belts from the motor horsepower to which apply the service factor to obtain the design horsepower. Determine the corrected horsepower per belt by multiplying the nominal horsepower per belt by an arc of contact factor not greater than 0.85. Divide the design horsepower by the corrected horsepower per belt to obtain the number of belts required. In any case, furnish not less than two belts for each drive.

B. Furnish belts that have been factory or factory-authorized distributor matched and measured on a belt-matching machine. Selection by "code numbers," "sag numbers" or "match numbers" is not acceptable. Bind each belt set with wire and tag with equipment identification.

C. Manufacturers:

1. Emerson Power Transmission; Browning; AX, BX, and CX Series and 3VX and 5VX Series.
2. Rockwell Automation; Dodge; Classic Cog and Narrow Cog V-Belts.
3. T.B. Wood's Incorporated; Classical Cog and Narrow Cog V-Belts.

2.9 V-BELT DRIVE MOTOR BASES

A. Furnish fan motors with slide or adjustable pivoted bases wherever equipment configuration permits proper installation.

B. Provide for adjustment of both belt tension and alignment.

2.10 AIR HANDLING SYSTEM BALANCING PROVISIONS

A. Provide extra sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each air handling system during air quantity balancing operations. Furnish sheaves as specified in this Section.

2.11 FLEXIBLE COUPLINGS (DIRECT DRIVE)

A. Fan shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape, in shear, or a solid mass serrated edge disc shape, made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration or end thrust.

B. Manufacturer:

1. Falk Corporation (The).

2.12 MOTOR REQUIREMENTS

A. Furnish motors in accordance with Division 20 Section "Motors."

2.13 FAN BEARINGS

A. Bearings: Anti-friction ball or roller type with provision for self-alignment and thrust load. Made in U.S.A. with ABMA L_{10} minimum life of 200,000 hours. Use cast iron housings and dust-tight seals suitable for lubricant pressures.

1. Lubrication Provisions - Use surface ball check type supply fittings. Provide extension tubes to allow safe maintenance while equipment is operating. Provide manual or automatic pressure relief fittings to prevent overheating or seal blow-out due to excess lubricant or pressure. Arrange relief fittings opposite supply but visible for normal maintenance observation.
2. Bearings on Equipment with less than 1/2 horsepower rating or on shafts smaller than 1-3/4 inch in diameter: Permanently sealed, pre-lubricated anti-friction bearings per specified materials and ABMA L_{10} life requirements.

2.14 IDENTIFICATION

A. Nameplate: Affix metallic, corrosion-resistant data plate for each fan in a conspicuous location. Include selection point capacity conditions.

2.15 ACCESSORIES

A. Bird Screens: Of material to match adjacent contact construction, 1/2 inch mesh or equal expanded metal. Use on inlet or outlet of each nonducted fan.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field Rigging: Do not negate balancing. Do not bend shaft. Use lifting eyes.

B. Install sheaves where recommended by Testing, Adjusting, and Balancing agency.

C. Refer to individual Division 23 HVAC equipment Sections for additional requirements.

END OF SECTION 230500

SECTION 230523 - GENERAL-DUTY VALVES 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.

B. Related Sections include the following:

1. Division 20 Section "Mechanical Identification" for valve tags and charts.
2. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
3. Division 22 Section “General-Duty Valves for Plumbing” for plumbing valves.
4. Division 23 Section "Temperature Controls" for control valves and actuators.

1.2 SUMMARY

A. This Section includes valves for general HVAC applications. Refer to piping Sections for specialty valve applications.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NRS: Nonrising stem.
4. OS&Y: Outside screw and yoke.
5. SWP: Steam working pressure.
6. TFE: Tetrafluoroethylene plastic.
7. WOG: Water, oil, and gas.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

1.6 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 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.
6. Block 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 handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

A. Isolation valves are scheduled on the Drawings. For other general HVAC valve applications, use the following:

1. Shutoff Service: Ball, butterfly valves.
2. Throttling Service Ball, butterfly, or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

D. For valves not indicated in the Application Schedules, select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
5. For Grooved-End Systems: Valve ends may be grooved. Do not use for steam or steam condensate piping.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

G. Valve Actuators:

1. Handwheel: For valves other than quarter-turn types.
2. Lever Handle: For quarter-turn valves NPS 6 and smaller.

H. Extended Valve Stems: On insulated valves.

I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

J. Valve Grooved Ends: AWWA C606.

K. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.

L. Threaded: With threads according to ASME B1.20.1.

M. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Series 70-140.
b. Crane Co.; Crane Valves.
c. Hammond Valve.
d. Kitz Corporation; Kitz Valves.
e. Milwaukee Valve Company; Model BA100S.
f. NIBCO INC.; Models S-580-70-66 or T-580-70-66.
g. Watts Water Technologies, Inc.

2.3 GENERAL SERVICE BUTTERFLY VALVES

A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.
2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12 , 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD 145.
b. Bray International, Inc.
c. DeZurik.
d. Emerson Automation Solutions; Keystone.
e. Forum Energy Technologies; ABZ Valve.
f. Hammond Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.; LD-2000-3/5.
i. Tyco Flow Control; Grinnell Flow Control.
j. Watts Water Technologies.

C. Grooved-End Butterfly Valves with EPDM-Encapsulated, or Electroless Nickel Coated Ductile-Iron Disc: Ductile-iron body with grooved or shouldered ends and polyamide coating inside and outside; Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12. Valve design shall provide bi-directional, bubble tight seal from full vacuum to 300 psig.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ASC Engineered Solutions.
b. NIBCO INC.; Model GD-4765-3/5.
c. Victaulic Co. of America.

2.4 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 150, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.
b. Crane Co.; Crane Valves.
c. Crane Co.; Stockham Div.
d. Hammond Valve.
e. Milwaukee Valve Company; Model 515.
f. NIBCO INC.; Models S-433-B or T-433-B.
g. Watts Water Technologies.

2.5 IRON SWING CHECK VALVES

A. Iron Swing Check Valves, General: MSS SP-71.

B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.
b. Crane Co.; Crane Valves.
c. Crane Co.; Stockham Div.
d. Hammond Valve.
e. Milwaukee Valve Company; Model F-2974.
f. NIBCO INC.; Model F-918-B.
g. Watts Water Technologies.

C. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Victaulic Co. of America; 716/716H/779.
b. NIBCO, INC.; Model G-917-W.
c. ASC Engineered Solutions.

2.6 BRONZE OR STAINLESS STEEL LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bonomi USA, Inc.; Series S800.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.; Model S-480-Y or T-480-Y.
e. The Wm. Powell Company.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 250 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 584 Alloy C844 bronze; or ASTM A351-CF8M stainless steel.
e. Ends: Threaded or Solder.
f. Disc: PTFE, or TFE.

2.7 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. NIBCO INC.; Model W-910-B.
b. Mueller Steam Specialty.
c. Milwaukee Valve Company.
d. Hammond Valve.

2.8 BRONZE GLOBE VALVES

A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.

B. Class 150, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 300 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.
b. Crane Co.; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company; Model 590.
e. NIBCO INC.; Models S-235-Y or T-235-Y.
f. Watts Water Technologies, Inc.

2.9 CAST-IRON GLOBE VALVES

A. Cast-Iron Globe Valves, General: MSS SP-85 with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.

B. Class 125, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.
b. Crane Co.; Crane Valves.
c. Crane Co.; Stockham Valves.
d. Hammond Valve.
e. Milwaukee Valve Company; Model F-2981.
f. NIBCO INC.; Model F-718-B.
g. Watts Water Technologies, Inc.

2.10 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Bronze ball valve as specified in this Section.
2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 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.

END OF SECTION 230523

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Common Work Results for HVAC.”

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:

1. Air Systems:

a. Constant-volume air systems.
b. Variable-air-volume systems.

2. Hydronic Piping Systems:

a. Variable-flow systems.
b. Primary-secondary systems.

3. HVAC equipment quantitative-performance settings.
4. Kitchen hood airflow balancing.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of activities and procedures specified in this Section.

B. Include rebalancing of air systems, or system portions affected by recommended sheave changes.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. AHJ: Authority having jurisdiction.

C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

F. NC: Noise criteria.

G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

H. RC: Room criteria.

I. Report Forms: Test data sheets for recording test data in logical order.

J. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

K. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

M. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

N. TAB: Testing, adjusting, and balancing.

O. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

P. Test: A procedure to determine quantitative performance of systems or equipment.

Q. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

1.5 CLOSEOUT SUBMITTALS

A. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

B. Warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. Approved Balancing Agencies.

1. The TAB firm selected shall be from the following list:

    a. Airflow Testing Inc.; Lincoln Park, MI.
    b. Barmatic Inspecting Co., Inc.; Lincoln Park, MI.
    c. Ener-Tech Testing; Holly, MI.
    d. Enviro-Aire/Total Balance Co.; St. Clair Shores, MI.

e. International Test & Balance Inc.; Southfield, MI.
f. Quality Air Service; Portage, MI.

C. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a. Submittal distribution requirements.
b. The Contract Documents examination report.
c. TAB plan.
d. Work schedule and Project-site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

E. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." TAB firm's forms approved by Architect.

F. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

G. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.7 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.9 WARRANTY

A. National Project Performance Guarantee: If AABC standards are used, provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. Special Guarantee: If NEBB standards are used, provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

B. Examine system and equipment test reports.

C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

D. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

E. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

F. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

G. Examine strainers for clean screens and proper perforations.

H. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

J. Examine system pumps to ensure absence of entrained air in the suction piping.

K. Examine equipment for installation and for properly operating safety interlocks and controls.

L. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

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 strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts, or use reduced scale contract documents with notations.

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. Cut insulation, and drill ducts for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes with neat patches, neoprene plugs, threaded plugs, or threaded twist-on metal caps, and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

F. Check air flow within intake plenums and mixing boxes of air handling units for uneven flow and temperature stratification and prepare a report with profile elevations (temperature and velocity) on each coil or filter face for Architect.

G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

H. Verify that motor starters are equipped with properly sized thermal protection.

I. Check dampers for proper position to achieve desired airflow path.

J. Check for airflow blockages.

K. Check condensate drains for proper connections and functioning.

L. Check for proper sealing of air-handling unit components.

M. Check for proper sealing of air duct system.

3.5 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 fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Select required sheave sizes and advise installing contractor to change drive sheaves accordingly. Refer to Division 23 Section “Common Work Results for HVAC” for additional requirements.
5. Do not recommend 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 will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow at a point downstream from the balancing damper and adjust volume dampers until the proper airflow is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts, or use reduced scale contract documents with notations.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set system controls so automatic valves are wide open to heat exchangers.
6. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Equipment installed with pressure independent characterized control valves (PICCV) or auto-flow devices shall not require hydronic system balancing unless multiple coils are served from a single PICCV or auto-

flow device (Example: AHU coil banks with multiple coils). Measure flow through each PICCV and auto-flow device and compare measured value to scheduled value to verify proper valve/device was installed and valve is functional. Verify flow for 100 percent of PICCV and auto-flow devices. Report discrepancies.

G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

H. Measure the differential-pressure control valve settings existing at the conclusions of balancing, and record in report.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance variable-flow hydronic systems by following the “Proportional Balancing Procedure” in accordance with NEBB.

B. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Power factor.
6. Nameplate and measured voltage, each phase.
7. Nameplate and measured amperage, each phase.
8. Starter size.
9. Starter thermal-protection-element rating.
10. Fuse number and size.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Electric-Heating Coils: Measure the following data for each 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 and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Refrigerant Coils: Measure the following data for each coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.15 PROCEDURES FOR COMMERCIAL KITCHEN HOODS

A. Measure, adjust, and record the airflow of each kitchen hood. For kitchen hoods designed with integral makeup air, measure and adjust the exhaust and makeup airflow. Measure airflow by duct Pitot-tube

traverse. If a duct Pitot-tube traverse is not possible, provide an explanation in the report of the reason(s) why and also the reason why the method used was chosen.

B. After balancing is complete, do the following:

1. Measure and record the static pressure at the hood exhaust-duct connection.
2. Measure and record the hood face velocity. Make measurements at multiple points across the face of the hood. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter. Calculate the average of the measurements recorded. Verify that the hood average face velocity complies with the Contract Documents and governing codes.
3. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to room airflow patterns to achieve optimum results.

C. Visually inspect the hood exhaust duct throughout its entire length in compliance with authorities having jurisdiction. Begin at the hood connection and end at the point it discharges outdoors. Report findings.

1. Check duct slopes as required.
2. Verify that duct access is installed as required.
3. Verify that point of termination is as required.
4. Verify that duct air velocity is within the range required.
5. Verify that duct is within a fire-rated enclosure.

D. Report deficiencies.

3.16 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Air handling equipment and outlets: Plus or minus 5 percent.

a. Where terminal units serve 6 or more outlets within a common room, individual outlets may vary up to plus or minus 10 percent of design flow rates if overall room supply is within plus or minus 5 percent.

2. Heating-Water Flow Rate: 0 to minus 10 percent.
3. Cooling-Water Flow Rate: 0 to plus 5 percent.

3.17 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: As Work progresses, prepare 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.

3.18 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. 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, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
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 firm 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 varies from indicated values.
14. Test conditions for fans and pump performance forms including the following:

    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.

d. Face and bypass damper settings at coils.
e. Fan drive settings including settings and percentage of maximum pitch diameter.
f. Inlet vane settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

E. 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 outside, supply, return, and exhaust airflows.
2. Water flow rates.
3. Terminal units.
4. Balancing stations.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
j. Number of belts, make, and size.
k. Number of filters, type, and size.

2. Motor Data:

a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Power factor efficiency.

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. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.
m. Vortex damper position.

G. 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. Outside-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.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btuh.
i. High-fire fuel input in Btuh.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btuh.
m. Motor voltage at each connection.

n. Motor amperage for each phase.
o. Heating value of fuel in Btuh.

H. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

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.

I. 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.

J. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device 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.

K. 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.

L. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:

a. Unit identification.
b. Location.

c. Unit make and model number.
d. Compressor make.
e. Compressor model and serial numbers.

2. Test Data (Indicated and Actual Values):

a. Inlet-duct static pressure in inches wg.
b. Outlet-duct static pressure in inches wg.
c. Entering-air, dry-bulb temperature in deg F.
d. Leaving-air, dry-bulb temperature in deg F.
e. Condenser entering-water temperature in deg F.
f. Condenser leaving-water temperature in deg F.
g. Condenser-water temperature differential in deg F.
h. Condenser entering-water pressure in feet of head or psig.
i. Condenser leaving-water pressure in feet of head or psig.
j. Condenser-water pressure differential in feet of head or psig.
k. Control settings.
l. Voltage at each connection.
m. Amperage for each phase.
n. Kilowatt input.
o. Crankcase heater kilowatt.
p. Number of fans.
q. Condenser fan rpm.
r. Condenser fan airflow rate in cfm.
s. Condenser fan motor make, frame size, rpm, and horsepower.
t. Condenser fan motor voltage at each connection.
u. Condenser fan motor amperage for each phase.

M. 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 and serial numbers.
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 rpm.
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.

N. Air-to-Air Heat-Recovery Unit Reports:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Service.
    d. Make and type.
    e. Model and serial numbers.

2. Motor Data:

    a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. If fans are an integral part of the unit, include the following for each fan:

    a. Make and type.
    b. Arrangement and size.
    c. Sheave make, size in inches, and bore.
    d. Sheave dimensions, center-to-center, and amount of adjustments in inches.

4. Test Data (Indicated and Actual Values):

    a. Total exhaust airflow rate in cfm.
    b. Purge exhaust airflow rate in cfm.
    c. Outside airflow rate in cfm.
    d. Total exhaust fan static pressure in inches wg.
    e. Total outside-air fan static pressure in inches wg.
    f. Pressure drop on each side of recovery wheel in inches wg.
    g. Exhaust air temperature entering in deg F.
    h. Exhaust air temperature leaving in deg F.

i. Outside-air temperature entering in deg F.
j. Outside-air temperature leaving in deg F.
k. Calculate sensible and total heat capacity of each airstream in MBh.

O. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.19 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Measure sound levels at two locations.
e. Measure space pressure of at least 10 percent of locations.
f. Verify that balancing devices are marked with final balance position.
g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The 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.
4. If the 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."
5. 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.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing 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 testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230933 - TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Testing, Adjusting, and Balancing.”

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

A. BACnet: Communications open protocol for building automation system networks and control (developed by ASHRAE and documented per ANSI/ASHRAE Standard 135-2012.

B. BAS: There is no Building Automation System other than a LOYTEC LVIS 15” panel for system information display that is wired to the BACnet network and communicates with the Network Supervisor for system and graphical information.

C. CAD: Computer Aided Design.

D. DDC: Direct-digital controls.

E. TC: Temperature Control.

1.4 SYSTEM DESCRIPTION

A. Temperature control Building Automation System (BAS) consisting of direct digital control system controllers, sensors, transducers, relays, switches, data communication network, etc. and all associated control wiring and raceway systems.

B. BAS/DDC system programming, database generation. Graphic display generation accessible through Building Network Supervisory Controller or at the remote operator workstation (when applicable for project).

C. Gas Detection and Monitoring System.

D. Electric thermostats, control valves, dampers, operators, control wiring, etc.

E. Electric and electronic control accessories, and other control system devices.

F. LOYEC BACnet monitor for BAS display.

1.5 SEQUENCE OF OPERATION

A. Control sequences for HVAC systems, subsystems, and equipment are indicated on project drawings.

1.6 SUBMITTALS

A. Submit under Division 20 and 23 provisions of respective project and as supplemented in this section.

B. All control submittal requirements shall be submitted at one time with exception to control valves, automated dampers, and initial phases of work associated with fast-track projects (when required). Early submittals of control valves and automated dampers shall be incorporated with the complete temperature controls submittal.

C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Each control device labeled with setting or adjustable range of control

D. 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.

E. Shop Drawings:

1. Shop drawings shall be done on CAD. Minimum size 11” x 17”.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
4. Details of control enclosure including panel faces and interior, including controls, instruments, terminations blocks and component labeling.
5. Written sequence of operation for each controlled system.
6. Schedule of dampers including size, leakage, and flow characteristics (Refer to Design Data).
7. Schedule of valves including leakage and flow characteristics (Refer to Design Data).
8. Complete bill of materials to identify and quantify all control components.
9. Overall system schematic showing communication trunk cabling from Building Network Supervisory Controller(s) to BAS field level controllers including component locations and wire termination details.
10. DDC controller layouts showing connected data points and LAN connections. DDC controller terminations including power supply and remote control component termination details shall be provided.

11. Point list for each DDC controller including point descriptions and addresses. This information may be incorporated with DDC controller layouts.

F. Graphic Displays: One month after TC Shop Drawing submittal, TC Contractor shall submit graphical display backgrounds for preliminary Engineer review. Concept for each floor plan, each system, each terminal unit template. Engineer understands that final representation of graphics may not be available until BAS database is established during course of construction. Thorough graphics review will be conducted by Engineer as part of the TC/BAS acceptance procedure.

G. Design Data: Provide indicated component selection and sizing criteria for the following component categories:

1. Control valves:

a. Component tag.
b. Equipment served/function.
c. Media type.
d. Design flow rate (GPM or lbs./hr.).
e. Design pressure drop (ft. head) or (psi), where applicable.
f. Calculated valve Cv, where applicable.
g. Selected valve Cv, where applicable.
h. Resultant pressure drop (ft. head) or (psi) with selected valve.
i. Valve size.
j. Line size to valve connection (excluding reducers).
k. Type (ball, butterfly, globe, etc.).
l. Configuration (2-way, 3-way mixing, 3-way diverting).
m. Normal position (normally open, normally closed, floating).
n. Actuator spring range (where applicable).
o. Actuator power requirement.
p. Valve shut-off rating (ft. head) of (psi)
q. Valve body pressure/temperature rating.
r. Valve manufacturer/model number.
s. Actuator manufacturer/model number.

2. Dampers:

a. Component tag.
b. Equipment served/function.
c. Overall damper size (inch width x inch height).
d. Quantity of damper sections with respective size(s)
e. Material and gauge of thickness.
f. Mounting orientation (horizontal or vertical).
g. Blade configuration (parallel or opposed)
h. Pressure drop (in. WG).
i. Shut-off rating/differential pressure rating (in. w.g.)
j. Leakage rating (CFM/sq. ft. at 4 in. w.g.)
k. Normal position (normally open, normally closed, floating).
l. Actuator spring range (where applicable).
m. Actuator power requirement.
n. Actuator torque requirement.

o. Actuator quantity.
p. Damper manufacturer/model number.
q. Actuator manufacturer/model number.

3. Flow measuring probes - Air:

a. Component tag.
b. Equipment served/function.
c. Duct dimension (inch width x inch height) if applicable.
d. Fan inlet diameter (inch) if applicable)
e. Probe quantity.
f. Probe length (inch).
g. Flow rate (CFM).
h. Flow velocity (FPM).
i. Probe manufacturer/model number.
j. Transmitter manufacturer/model number.

H. Wall mounted temperature sensor, thermostat and/or other temperature control device cover color shall be coordinated to match color of wall mounted electrical device components and cover plates – coordinate with electrical contractor. Provide samples of available temperature control device cover colors to Architect upon request or if available temperature control device colors do not match electrical device colors so a desired color selection may be determined. Provide sample of temperature sensor / thermostat guard upon request of Architect, Engineer or Owner.

I. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

J. Submit field reports indicating operating conditions after detailed check out of systems at Date of Substantial Completion.

K. Project Record Documents: Include the following:

1. Revise Shop Drawings to reflect actual installation and operating sequences.
2. Record actual locations of control components, including control units, thermostats, and sensors.
3. Submit the electronic files for all as-built shop drawings in pdf format on USB Flash Drives (3 Total).

L. Software and Firmware Operational Documentation: Include the following:

1. DDC controller keypad operating instructions and DDC controller override features, where applicable.
2. Device address list.
3. Program Software Backup: On a magnetic media or compact disc, complete with data files.
4. Software license required by and installed for DDC workstations and control systems.
5. DDC workstation software operating instructions for scheduling equipment, trending data, displaying graphics, commanding points, adding/deleting/modifying points, changing setpoints, and setting up alarms.
6. Advanced DDC workstation operating instructions for graphics generation, control sequence programming and program modification.
7. Printout of software applications and graphic screens.

M. Maintenance Manuals: Include the following:

1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
2. Keypad illustrations and step-by-step procedures indexed for each operator function, where applicable.
3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.

1.7 REFERENCES

A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

B. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure fittings.

C. ANSI/ASTM B32 - Solder Metal.

D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

F. ASTM B75 - Seamless Copper Tube for General Engineering Purposes.

G. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.

H. ASTM E1 - Specification for ASTM Thermometers.

I. MMC – Michigan Mechanical Code, version applicable for project.

J. NEMA DC 3 - Low-Voltage Room Thermostats.

K. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics Only.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is a certified and approved installer of the BAS software and automatic control system (DDC) manufacturer for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

C. 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.

D. Comply with all applicable code requirements for project.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated or optional to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION

A. Coordinate work under Division 20 and 23 provisions and as supplemented in this section.

B. Coordinate location of space temperature sensors, space humidity sensor, thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

C. Coordinate installation of system components with installation of mechanical systems and equipment to achieve compatibility.

D. Ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate control wiring requirements, including actual terminal block numbers, with mechanical equipment manufacturers or suppliers.

F. Coordinate equipment with Division 26 Section "Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

G. Coordinate equipment with Division 28 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

H. Ensure control system installation is complete, checked, tested and functioning properly prior to system balancing and Owner/Engineer system checkout.

I. Cooperate fully with the Test and Balance Contractor and provide labor to operate the temperature control system as required to meet the scope of work defined in Division 23 Section "Testing, Adjusting and Balancing."

1.11 WARRANTY

A. Provide warranty per Division 20 Section "Mechanical General Requirements" and as supplemented in this section.

B. Provide 24 hour per day emergency service during warranty period, with maximum response period of four (4) hours. Provide phone number(s) for quick assistance by a Service Engineer regarding hardware or software problems.

C. Provide scheduled maintenance service during warranty period to inspect, calibrate, and adjust controls. Make a minimum of one eight-hour service call every three months. Notify Owner prior to each scheduled inspection trip. Submit written reports upon completion of service.

D. Provide any software or firmware revisions which are released by the DDC system manufacturer during the warranty period, at no additional cost to the Owner.

1.12 POSTED OPERATING INSTRUCTIONS

A. Provide DDC controller related as-built documents in protective binder or clear plastic display envelope for each control enclosure panel. These instructions shall include such items as as-built control diagrams and sequence of operation, simplified narrative instructions and materials necessary to aid in the operation of the equipment at the local control panels.

1.13 SPECIAL TOOLS

A. Deliver two sets of any special tools required for operation, adjustment, resetting or maintenance, excluding PC laptop.

1.14 PROTECTION OF PROPRIETARY INFORMATION

A. Non-disclosure agreement(s) that may be subject to proprietary manuals and software shall be submitted by the proprietary equipment manufacturer to the Owner for approval and signature during the warranty period.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM (BAS)

A. The building automation system (BAS) shall be fully integrated, distributed data processing system incorporating direct digital control (DDC) for the control and monitoring of heating, ventilating and air conditioning (HVAC) equipment and other related systems. Microprocessor based BAS field level DDC controllers shall be directly connected to HVAC equipment sensors and actuators. A data communication network shall allow data exchange between the BAS field level DDC controllers and the Building Network Supervisory Controller. The Building Network Supervisory Controller shall be the primary operator BAS interface point for the building through network supervisory controller and through Operator Workstation (LOYTEC).

B. Approved Manufacturer – System / Approved Installer (Locations) as listed:

1. Distech Controls with BACnet Controllers / by:

a. Conti Corp Controls Group. (Sterling Heights, MI).
b. Control Solutions Inc. (Madison Heights, Byron Center, MI).
c. Johnson Controls, Inc. (Auburn Hills, MI) – NOT Metasys Products.
d. Metro Controls, Inc. (Clinton Twp, MI).
e. SyEnergy Engineering Services, (Rochester Hills, MI).
f. Trane U.S. Inc., Southeast Michigan (Livonia, MI) – NOT Trane ICS Products.
g. W.J. O'Neil Controls Group. (Livonia, MI).

2. Honeywell – WEBS with BACnet Spyder ILC Controllers / by:

a. ControlNet (Swartz Creek, Kalamazoo & Grand Rapids, MI).
b. Green Building Automation, (Plymouth & Kalamazoo, MI).

c. Knight Watch/Vertex Integration (Hudsonville, MI).
d. SyEnergy Engineering Services, (Rochester Hills, MI).
e. SysTemp Corporation. (Rochester Hills, MI).

3. Johnson Controls – Facility Explorer with FX Controllers / by:

a. BASS Controls (Sterling Heights, MI).
b. Conti Corp Controls Group. (Sterling Heights, MI).
c. ControlNet (Swartz Creek, Kalamazoo & Grand Rapids, MI).
d. Control Solutions Inc. (Madison Heights, Byron Center, MI).
e. Green Building Automation, (Plymouth & Kalamazoo, MI).
f. Johnson Controls, Inc. (Auburn Hills, MI) – NOT Metasys Products.
g. K&S Ventures, Inc. (Rochester Hills, MI).
h. Knight Watch (Troy & Hudsonville, MI).
i. Limbach Company. (Pontiac, MI).
j. Metro Controls, Inc. (Clinton Twp, MI).
k. Michigan Environmental Controls, Inc. (New Hudson, MI).
l. SyEnergy Engineering Services, (Rochester Hills, MI).
m. SysTemp Corporation. (Rochester Hills, MI).
n. Wadsworth Solutions (Southfield, MI & Perrysburg, OH)
o. W.J. O'Neil Controls Group. (Livonia, MI).

2.2 BAS BUILDING NETWORK SUPERVISORY CONTROLLER (TRIDIUM N4 PLATFORM)

A. The Building Network Supervisory Controller, utilizing the HTML5 platform, shall provide the interface between the DDC field controllers and devices, LOYTEC L-VIS display, and provide global supervisory control functions over the control devices connected to the NSC. It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling.
3. Trending.
4. Alarm monitoring and routing.
5. Time synchronization.
6. Integration of BACnet controller data.
7. Network Management functions for all BACnet based devices.

B. The Network Area Controller shall provide the following hardware and driver features as a minimum:

1. One RS-232 port
2. One RS-485 port with BACnet MS/TP Driver.
3. Battery Backup
4. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity).
5. Where the option for expanded memory is available, it must be supplied.

C. Provide BACnet and MODBUS driver(s) as required for system or equipment integration requirements for project.

D. The network supervisory controller shall be sized appropriately per building to handle the required quantity of connected controllers and devices.

E. Provide 5-year service agreement per network supervisory controller for updating firmware/software as available by manufacturer. Labor for updating the controllers shall be included.

F. For Tridium based systems, provide Niagara 4 JACE-8000 series network supervisory controllers.

G. Manufacturer:

1. Vykon N4 JACE-8000 series is to be used in lieu of listed manufacturer's standard product per requirements of Owner's existing network or as indicated on the construction drawings

2.3 DIRECT DIGITAL CONTROL (DDC) FIELD LEVEL CONTROLLERS

A. Modular in design and consisting of stand-alone microprocessor board with ROM and fully custom programmable RAM, EPROM, and/or EEPROM memory, integral interface equipment and power surge protection. DDC controllers shall be connected directly to sensors, controlled devices, and the communication network.

B. Powerfail Restart and Battery Backup: Minimum of 72-hour battery backup for complete system RAM memory and clock, with automatic battery charger or 48-hour low voltage alarm warning. Upon full system power recovery, all clocks shall be automatically synchronized, and all controlled equipment shall be automatically re-started based on correct clock time and sequence of operation.

C. Provide fully functional communication interface ports for communication between processor, other processors, portable programmer's terminal, portable operator's unit, or the Operator Workstation when applicable for project.

D. Panel enclosure for controller, associated power supply and other ancillary control components shall be finished steel or rigid plastic with hinged door and keyed lock. Electronics shall be removable for protection during mounting of panel.

2.4 DDC CONTROLLER SOFTWARE

A. Operating system shall work in real time, provide prioritized task scheduling, control time programs, monitor DDC controller communications, scan inputs and outputs, and contain built-in diagnostics.

B. Input/Output point processing shall include the following:

1. Continuous update of input and output values and/or conditions. All connected points are to be updated at least once per second.
2. Assignment of proper engineering units and status condition identifiers to all points.
3. In addition to physical or "hardware" points required, "software" points shall be provided where required for command access and meaningful displays, where required by the "execution" portion of this section or where required on the DDC Input/Output points lists. "Software" points shall appear identical to physical points in output displays and shall be assignable to text descriptors, logical

groups, reports, etc. in the same manner as physical points. "Software" points shall be assigned alarm limits in the same manner as physical points.

C. Command control software shall manage the receipt of commands from control panels, portable programmer's terminal, portable operator's unit or the remote Operator Workstation when applicable for project.

1. Command delay, programmable from 0 to 2 minutes, shall be provided to prevent simultaneous energizing of large loads. Command delays shall be honored throughout the BAS DDC network, not just within the DDC controller. Delays shall be assignable on an individual per point basis.
2. Each command shall be assigned a command and residual priority to manage contentions created by multiple programs having access to the same command point. Only commands with a higher command priority than the existing residual priority shall be permitted to execute. Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority.
3. A "fixed mode" option shall be supported to allow inputs to, and outputs from DDC control programs to be set to a fixed state or value. When in the "fixed mode," inputs and outputs shall be so noted in all reports.
4. A "last user" record is to be maintained to positively identify which program or manual command is in control of a given point. The last user information shall be displayed and printed along with other point data of logical groups.

D. Provide self-test procedure. Notify remote Operator Workstation (when applicable for project) for maintenance, performance, software, cable break, or data transmission problems. Identify variables as reliable or unreliable. Variables identified as unreliable shall use default in calculation.

E. Alarm Processing

1. High/Low Alarm: Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons are to be made each scan cycle.
2. Floating Alarm: Where analog controlled values are automatically varied by software (such as hot water temperature reset), a single set of alarm limits shall be provided for those varying values. These alarm limits shall then "float" a user definable differential above and below the varying setpoint value.
3. Abnormal Alarm: When a digital input is not in agreement with the commanded state of its associated output point, or when a digital input is not in its normal state, an abnormal alarm shall be generated. Abnormal "on" shall cause an alarm, as well as abnormal "off." Alarm time delay for digital inputs to prevent nuisance alarms shall be provided. Each digital input alarm time delay shall be adjustable from zero to two minutes in one-second increments.
4. Alarm lockout shall be provided to positively lock out alarms when equipment is turned off or when a true alarm is dependent on the condition of an associated point. Lockout points and lockout initiators shall be operator programmable. On initial startup of air handler and other mechanical equipment, a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Timed lockout period shall be programmable on a per point basis from 0 to 90 minutes in one-minute increments.
5. The capability of automatically initiating commands upon the occurrence of an alarm.

F. Totalization

1. Run time shall be accumulated based on the status of digital input points. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Run time counts shall be resident in memory and have DDC controller resident run time limits assignable through portable programmer's terminal, portable operator's unit or the remote Operator Workstation when applicable for project.
2. A transition counter shall be provided to accumulate the number of times a device has been cycled on or off. Counter shall be capable of accumulating 600,000 switching cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.
3. Analog totalization capability shall be provided to allow the totalization of electricity, air, water and steam flow, etc. These flows shall be totalized with respect to time and converted to the appropriate energy unit. It shall be possible to automatically set time intervals for totalization, adjustable from one second to 365 days. The totalization program shall keep track of the maximum and minimum instantaneous analog value measured during the period, including the date and time at which each occurred.

G. DDC Controller Programming / Configuration

1. All DDC controllers shall be fully programmable or configurable per required controller application type. DDC controllers which require remote or factory programming or configuration are not acceptable. DDC controllers with custom programs which may not be modified by the user are not acceptable. "Custom" programming shall mean allowing the alteration of actual control logic, and shall not be limited to allowing only the alteration of setpoints, gains, parameters, time constants, etc.
2. DDC controllers shall be provided to meet the control strategies as called for in the sequences of operation on the drawings. If a configurable application specific DDC controller cannot meet this requirement, a DDC fully programmable controller shall be provided.
3. All DDC controller setpoints, gains, parameters, time constants, etc., associated with DDC controller programs shall be available to the operator for display and modification via portable programmer's terminal, portable operator's unit or the remote Operator Workstation when applicable for project.
4. Each DDC controller shall have resident in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, and arithmetic, logic and relational operators for implementation of control sequences. Functions to be provided shall include, but not be limited to, the following:

    a. Mathematical: Absolute value, calculate, square root, power, sign, average, totalize.
    b. Logic: OR, AND, compare, negate.
    c. Fixed Formula: High and low select, span, rate, ramp, enthalpy, wet bulb, dew point, relative humidity, humidity ratio, and filter.
    d. Data Manipulation: Store, file and set.
    e. Control Routines: Real-time based functions, proportional control, proportional-integral control, proportional-integral-derivative control, adaptive control (self-tuning), direct-acting, reverse acting, feedforward, fixed setpoint, calculated setpoint, adjustable setpoint, lead lag, hysteresis correction, event initiation/ software interlock.

H. Building Automation System program applications (as required for controllers)

1. Time of Day Scheduling: Allow the creation and maintenance of operating schedules for selected points based on time of day and holiday scheduling. At least two independent start and stop times per day for each system shall be allowed. Each point shall be allowed to have a unique time program, or points shall be able to be grouped and assigned to a common time program. Both digital and

analog output points shall be able to be assigned to a time program. This software shall work in conjunction with the time-of-day scheduler software at the remote Operator Workstation (when applicable for project). This program shall also work in conjunction with the optimum start and optimum stop application software.

2. Optimum Start: Start equipment based on outdoor temperature, space temperature, and system response to minimize energy usage and to assure that comfort conditions are reached exactly at scheduled occupancy time (occupancy schedules are defined under "Time of Day Scheduling"). This program shall operate in both the heating and cooling cycles. An adaptive algorithm shall be employed which automatically adjusts the start time according to previous performance and shall automatically assign longer lead times for weekend and holiday shutdowns.
3. Enthalpy Optimization: Using standard psychrometric calculations, automatically determine which air source, outdoor air or return air, presents the least total heat load, and automatically adjust mixed air damper position. When outside enthalpy exceeds return air enthalpy, the outside air damper shall go to its minimum position. Typically, the outside air damper must be in its minimum position before the cooling coil valve is allowed to open.
4. Duty Cycle: Periodically cycle electrical equipment to reduce energy consumption and/or energy demand. Each load shall be assigned a cycle interval and an off period. A load leveling algorithm shall be utilized to assure that cycle periods do not coincide.
5. Demand Limiting: Distributed power demand program shall be based on a sliding window instantaneous demand algorithm. The DDC controller(s) connected to the demand meter shall calculate the demand, forecast the demand trend, compare it to established demand limits, and initiate load shedding action or reestablishment of loads as required. Shedding shall be on a sequential basis with least important loads shed first and restored last. Restoration cycle shall add the most important loads first. DDC controllers on the network shall each have a four-tier shed table for assignment of sheddable loads. When a request is issued to the network to shed a specific number of kilowatts, each DDC controller shall shed Tier 1 loads, Tier 2 loads, etc. until the shed requirement is met. The program shall have the capability to sum the readings from multiple meters connected to multiple DDC controllers on the network, and to shed various loads from multiple DDC controllers on the network.
6. Warm-Up: Position the outside air dampers in an adjustable (minimum) position and trigger a digital output(s) normally used to signal air terminal units to move to their maximum flow settings. When the desired space temperature is reached, as determined by feedback from space temperature sensor(s), the digital output shall return the air terminal units to their normal operation. When occupancy time is reached, the outside air dampers shall be controlled by the normal occupied mode control sequence. During the warm-up cycle, the outside air damper shall be set at the position which minimizes outside air intake while preventing over/under pressurizing of ductwork. This program shall work in conjunction with the time scheduling program and/or the optimum start program as required.
7. Night Cycle: Cycle HVAC equipment on and off as required to maintain an operator selectable unoccupied space temperature. During the equipment "on" time, the outside air damper shall be maintained in an adjustable position which minimizes outside air intake while preventing over/under pressurization of ductwork. The equipment shall be cycled such that energy reduction during unoccupied periods is uniform.
8. Night Purge: Night Purge program shall apply to cooling cycle only. Night Purge shall introduce 100% outdoor air any time the outdoor air is above 50 degrees F, the space temperature is above 75 degrees F, the outdoor air temperature is below space temperature and the outdoor air dew point is less than 60 deg F. Purging shall stop when outdoor air is below 50 deg F, or space temperature is below 75 deg F, or outdoor temperature is less than 5 deg F cooler than space temperature, or outdoor air dew point is greater than 60 deg F.
9. Reset Optimization: Adjust equipment discharge setpoints based on one of the following criteria:

a. By sensing the worst-case requirements (e.g., the zone requiring the most heating or cooling and providing only the minimum energy required to meet the load.
b. Adjusting the setpoint in direct proportion to another sensed variable (e.g., reset supply water temperature based on outside temperature).

2.5 DDC AIR TERMINAL UNIT CONTROLLERS

A. Microprocessor based controllers capable of stand-alone operation for control of pressure independent air terminal units. Controllers shall be networked together and connected to the building's BAS/DDC network.

B. Controllers shall have separate adjustable minimum and maximum airflow setpoints. Controllers shall work in conjunction with the air handling unit's DDC panel to provide the sequence of operation as indicated on the drawings. Setpoints shall be adjustable through the portable programmer terminal.

C. Provide electronic type air terminal unit damper operators compatible with the controller and the air terminal units provided.

D. Each controller shall have an internal differential pressure transducer capable of utilizing the total and static pressure signals from the air terminal unit's velocity sensor. Velocity sensor shall be furnished by air terminal unit manufacturer.

E. Each controller shall have electronic outputs compatible with the electronically operated air terminal unit tempering coil control valve and perimeter radiation control valve where applicable

F. TC contractor shall provide 24 VAC power requirements including transformers.

G. If coordinated with mechanical contractor. Controllers and damper operators shall be furnished to the air terminal unit manufacturer for factory mounting by the air terminal unit manufacturer; otherwise, controls shall be field installed.

H. Room temperature sensors for the DDC air terminal unit controllers:

1. Sensing Element: Thermistor or resistance temperature detector (RTD) type. Accuracy shall be+/- 0.5 degrees F over the range of 55 degrees F to 95 degrees F, including calibration error, repeatability, hysteresis, and yearly drift.
2. Cover: with tamper-proof fasteners.
3. Provide with exposed setpoint adjustment dial and exposed temperature reading.
4. Provide with exposed override switch to allow an occupant to reset the space to occupied control during the unoccupied cycle for a predetermined time period.
5. Provide with portable operator unit plug-in port.

2.6 DDC INPUT/OUTPUT SENSORS

A. Air Static/Differential Pressure Transmitters:

1. Variable capacitance type with ranges not exceeding 150 percent of maximum expected input. Transmitter shall have zero and span adjustments.
2. Safe overpressure rating shall be minimum 5 times the range.

3. Temperature compensated with thermal error of not greater than 0.04 percent of full scale in temperature range of 40 to 100 deg F.
4. Accuracy: +/- 0.5% of full-scale including calibration error, repeatability, hysteresis, and yearly drift.
5. Manufacturers:

    a. Air Monitor.
    b. Belimo.
    c. Dwyer.
    d. Modus
    e. Setra.

B. Carbon Dioxide Sensors:

1. Carbon dioxide sensing cell shall consist of a nondispersive infrared carbon dioxide gas cell that uses a pulsed source and has no free air optical path. Output shall be linearized 4-20 mA with the 24 VDC input. In addition, the unit shall be capable of providing SPDT switching of an external low voltage circuit at an adjustable setpoint. The unit shall be specifically designed for the wall or duct application specified. Return air aspiration boxes shall be designed by and approved by the manufacturer. Unit shall have single point setpoint and span adjustment. The unit shall have no moving parts.
2. Power for the sensor shall be extended from a transformer or adaptor installed adjacent to the DDC controller enclosure panel and shall be run parallel to the 4-20 mA signal cable.
3. Minimum sensing range shall be 0-2,000ppm.
4. Overall Accuracy shall be 3% of full-scale including calibration error, repeatability, hysteresis and yearly drift.
5. Minimum calibration interval shall be 5 years.
6. Contractor shall provide all necessary equipment and test gas for calibration and shall calibrate all CO_2 sensors in accordance with the manufacturer's recommendations.
7. Manufacturer:

    a. Specified BAS product where available that meets the requirements herein.
    b. Belimo.
    c. TelAire.
    d. Vaisala.
    e. Veris.

C. Current Switches:

1. Split-core or donut type transformer for monitoring AC current, with digital output signal. Current switches used on motor side of variable frequency drives shall have low frequency detection capability.
2. Current switches with digital output shall have adjustable trip settings. Provide field adjustment of current switches to trip at approximately 90% of normal motor operating amperage.
3. Manufacturers:

    a. Johnson Controls.
    b. NK Technologies.
    c. Senva.
    d. Setra.
    e. Veris Industries.

D. Differential Pressure Transmitters:

1. Transmitters used for measuring differential pressure only:

a. Each differential pressure transmitter shall be selected and calibrated for operations between 0 and 200% of the normal differential pressure. The calibration point shall be rounded upward to the nearest 10 inches of water column (for spans less than 200" W.C.) or to the nearest 5 psi for larger spans. Calibration date shall be included on an embossed tag attached to each transmitter.
b. The accuracy, including linearity, hysteresis, and repeatability, of the transmitter for measuring differential pressure shall be better than 2% of the span stated above throughout a 4:1 turndown.
c. The transmitter shall not be damaged by pressures of up to 500 psig on either side of the transmitter and all wetted parts shall be essentially inert in the presence of up to a 40% concentration of ethylene or propylene glycol in water.
d. Provide a drain valve for each side of the pressure chamber. Furnish and install mounting brackets appropriate for the installation location.
e. Span and zero shall be individually adjustable.
f. With LCD Display.
g. Manufacturers:

1) Belimo.
2) Dwyer.
3) Setra.
4) Veris Industries.

2. Indication Gauges for Differential Pressure Transmitters:

a. Each transmitter shall come with an indicating gauge which reads in gpm or inches of water (whichever is the final value desired). The gauge may be either an analog differential pressure gauge piped in parallel to the transmitter or a digital display wired directly to the output of the transmitter.
b. The analog pressure gauge shall be selected and calibrated for the same span as the transmitter it serves.
c. The accuracy, including linearity, hysteresis and repeatability, of the gauge for measuring differential pressure shall be better than 3% of the span stated above throughout its span. Calibration data shall be included on an embossed tag attached to each gauge.
d. The gauge shall not be damaged by pressures of up to 500 psig on either side of the gauge and all wetted parts shall be essentially inert in the presence of up to 40% concentration of ethylene or propylene glycol in water.
e. Scale shall be a minimum of 4.5" long. Furnish and install two bleed fittings for each gauge and mounting brackets appropriate for the installation location.

3. Three Valve Manifold:

a. Provide a three-valve manifold for each transmitter. The manifold shall not be damaged by pressures of up to 500 psig and all wetted parts shall be essentially inert in the presence of up to a 40% concentration of ethylene glycol in water.
b. The manifold shall be designed for direct mounting on the transmitter it serves and utilize quarter-turn valves to provide zeroing, blocking and normal service modes.

E. Humidity Sensors:

1. Elements: Thin film or polymer capacitive type or bulk polymer resistance type with linear output, accurate within ± 2% RH throughout the range of 10-95% RH and drift to be less than +/-0.25%.
2. Humidity sensors shall be resistant to chlorine and other cleaning agents.
3. Room Sensors: With locking cover matching space temperature sensors used.
4. Duct Sensors: With duct probe and mounting plate.
5. Manufacturers:

    a. Specified BAS product where available that meets the requirements herein.
    b. Belimo.
    c. GE Industrial, Sensing (formerly General Eastern)
    d. Rotronic.
    e. Vaisala.
    f. Veris – HD/HO Series.

F. Outside Air Temperature/Humidity Combination Transmitters:

1. Dual transmitters housed in a single hinged enclosure with integral probes configured for exterior wall mount application with PVC sun shield. Unit shall provide separate 4-20 mA signals for temperature and humidity measurement.
2. Temperature sensor: Refer to Temperature Sensors specifications. Range of operation shall be -25 degrees F to 125 degrees F.
3. Humidity sensor: Refer to Humidity Sensors specifications. Range of operation shall be 0-100% RH.
4. Manufacturer:

    a. Belimo.
    b. Vaisala.
    c. Veris.

G. Temperature Sensors:

1. Resistance temperature detectors (RTD) with 1000 ohm, thin-filmed platinum, nickel or Balco element having 0.000385 temperature coefficient meeting the input requirements of the DDC controller.
2. Thermally sensitive resistors (thermistor) shall be 10k-type, epoxy or glass coated, having NTC characteristic, meeting the input requirements of the DDC controller.
3. Initial calibration accuracy shall be +/- 0.5 deg F over the entire range. Range shall be as indicated below, or as appropriate to the application.
4. Additional error such as repeatability, stability, tolerance, linearity and hysteresis shall not exceed an additional +/- 0.5 deg F additive (using RMS method) throughout the selected operating range for the application.
5. Temperature sensors shall be resistant to chlorine and other cleaning agents
6. Single point duct mounted sensors shall have 18" rigid probe and calibrated span of 20 - 120°F.
7. Averaging duct mounted sensors shall have 25' long averaging element and calibrated span of 20 - 120°F.
8. Liquid immersion sensors shall have welded stainless steel thermowells for ferrous pipe and brass thermowells for copper pipe. Length of sensor and thermowell shall be selected based on the diameter of the pipe to provide accurate, reliable, and homogeneous sensing of the liquid temperature. Thermowell pressure rating shall meet or exceed the system minimum pressure rating.

Sensors for chilled water application shall have calibrated span of 20 - 120°F. Sensors for hot water applications shall have calibrated span of 40 - 240°F

9. Room sensors shall have locking cover and a minimum span of 40 - 90°F.
10. Outside air temperature (only) sensors shall have watertight inlet fitting and shall be shielded from direct rays of sun and wind.
11. Manufacturers:

    a. Specified BAS product where available that meets the requirements herein.
    b. ACI – except PT1000 averaging sensor.
    c. BAPI – Basys Series.
    d. Belimo.
    e. MAMAC
    f. Minco.
    g. TCS.

2.7 DDC DATA COMMUNICATIONS NETWORK

A. Data communication network shall be provided to allow data exchange between the BAS field level DDC controllers and the Building Network Supervisory Controller.

B. The BAS/DDC system-wide communication network shall consist of a primary peer-to-peer network, and at the Contractor's option, secondary sub-networks linked to the primary network. The primary network shall support peer-to-peer communications between primary network BAS field level DDC controllers. The Building Network Supervisory Controller shall be connected to the primary network. Secondary sub-networks when used shall interface with the primary network though the primary network BAS field level DDC controllers. At least one DDC controller connected to the primary peer-to-peer network shall be provided in each mechanical room, or as indicated on the drawings.

C. Data communications media shall be twisted pair wires.

D. The communications network shall allow shared point and control information between BAS field level DDC controllers. All required repeaters, hubs, active links, gateways, etc. and associated power supplies shall be provided as required to provide shared point and control information between BAS field level DDC controllers.

E. Failure of any individual BAS field level DDC controller shall not cause the loss of communications between peer BAS field level DDC controllers.

F. All data transmitted must be positively acknowledged as received or negatively acknowledged as not received. Negative acknowledgments shall cause a retransmission of the data. Network connected devices must send a "functioning" message each network cycle. Lack of a "functioning" message after successive retries shall constitute a device failure and shall be recognized as such by the network.

G. Error recovery and communication initialization routines shall be resident in each network connected device.

2.8 DDC (JACE 8000) OPERATOR WORKSTATION SOFTWARE

A. Operating System.

1. Real time-based system which shall provide true multi-tasking capability. Multi-tasking shall allow the user to perform concurrent execution of multiple real time tasks.
2. It shall not be acceptable for background applications to be suspended while foreground applications are executed.

B. Database Manager.

1. Database manager shall manage all data on an integrated and non-redundant basis. It shall allow additions and deletions to the data base without any detriment to the existing data. Cross linkages shall be provided such that no data required by a software program may be deleted by the operator until that data has been deleted from its respective program.
2. Menus shall clearly guide the operator through the database editing process. Database editing shall not interfere with any other Operator Workstation function.
3. All database and/or program changes made at the Operator Workstation shall automatically be transferred from the Operator Workstation to the DDC Panels. All database and/or program modifications made at the DDC panels shall automatically be transferred to the Operator Workstation and stored on disk at the Operator Workstation.
4. Database Format:

    a. Divide points of control or monitoring by system.
    b. Identify points with unique, structured point identifier reflecting "specific area" or "specific system," and "specified point."

C. Operator Interface Software

1. General: Hierarchical linked dynamic graphical user interface for access and display of system data and for commanding and modifying equipment operation. The user interface shall utilize the mouse or keyboard to provide "heads up" operation with pull-down menus, dialogue boxes, zoom, coloration and animation to facilitate ease of operation of the system. Multiple levels of graphic penetration shall be provided with operator assignable hierarchy. Dynamic system data points shall be assignable to each penetration level. Descriptors for graphics, points, alarms, etc. shall be modified through the Operator Workstation (under password control).
2. Operator access and password protection:

    a. Operator access into the system shall require a password. A minimum of twelve (12) operators shall be able to be assigned a unique password. All sign-on/sign-off activity shall be automatically archived on the operator's station disk for subsequent display or printout as desired. The operator's initials shall be displayed on all reports and alarm acknowledgments.
    b. At least the following three levels of system access shall be assignable to each operator:

        1) Level 1: Monitoring only
        2) Level 2: Monitoring and Commanding
        3) Level 3: Monitoring/Commanding/Programming

3. Data to be displayed within a unique graphic shall be assignable regardless of physical hardware address, communication channel or point type. Graphics shall be on-line programmable and under password access control. Points shall be assignable to multiple graphics where necessary to facilitate operator understanding of system operation and where specified. Graphics shall also contain calculated or "software" points. Each physical point and each point assigned to a graphic shall be assigned an English descriptor for use in reports.

4. Data segregation shall be provided for control of specific data routed to a printer, another Operator Workstation, or other peripheral. Point classes shall be randomly selectable such as all HVAC points, HVAC points second floor, all space temperature points, command points, etc. Display and/or output of data to a printer or monitor shall occur where there is a match of peripheral segregation class assignment and the point segregations. Peripherals shall be assignable, and all assignments are to be on-line programmable and under password control.
5. Operator shall be able to use the mouse to move in either direction through the graphic penetration hierarchy. In addition to being able to move one level in either direction through the hierarchy, the operator shall also be able to go directly to a specific level or access a specific point without following a fixed penetration path.
6. Points shall be displayed with dynamic data provided by the system with appropriate text descriptor, status or value, and engineering unit. Coloration shall be used to designate status and alarm states. Coloration shall be variable for each class of points, as chosen by the Owner. All point displays shall be dynamic, with update rates user adjustable on a per point basis from 20 seconds to 120 seconds.
7. For operators with the appropriate password, points shall be commandable directly from the Operator Workstation using the mouse or keyboard. Each binary output point shall be displayed with its current status (e.g., Open) and shall be operator commandable to go to the opposite position. Each analog output point shall be displayed with its actual incremental status (e.g., 20% Open, 80% Open, 100% Open, etc.) and shall be operator commandable to be move to any incremental position.
8. The operator shall be permitted to split or resize the viewing screen to show one graphic on the left half of the screen and another graphic, point report, etc., on the right half screen. This shall allow real time monitoring of one part of the system while displaying other parts of the system or data from the system.
9. An on-line "help" utility shall be provided to facilitate operator training and understanding. The "help" utility shall contain text and graphics to clarify system operation. At a minimum, help shall be available for every menu item and dialogue box.
10. Electronic messaging facility shall be provided on the Operator Workstation for any operator to enter a message to another operator. When an operator with a queued message signs onto the operator station, the display shall indicate that a message is waiting. Messages shall include the time and date the message was sent and the sender's name.
11. The operator shall be able to easily obtain a hard copy of any graphic and/or text display.

D. Alarm Handling Software

1. General: Alarm handling software shall be provided to respond to alarm conditions sensed and transmitted from the DDC panels. Alarms shall be handled on a first in/first out basis in accordance with alarm priority ranking. A minimum of 20 alarms must be capable of being stored in case of simultaneous multiple alarms. Alarm handler shall be active whether or not an operator is signed on at any given time to assure that all alarms are processed at all times.
2. Alarms shall be displayed at the Operator Workstation with the following minimum information given for each alarm: Type of alarm condition, analog value or status, point descriptor, and action-taking message. Action-taking message, for each alarm, shall indicate possible corrective action as a text string capable of being up to 280 characters in length.
3. Alarms shall be assignable to appropriate Operator Workstations, operators or printers. Only those operators having the appropriate password access level shall be allowed to acknowledge alarms.
4. An alarm summary feature shall be provided to allow the operator to display and/or print out all current alarms.
5. Each point shall be assigned to an alarm class. Each alarm class shall be uniquely assigned any of the following alarm processing attributes:

a. Alarm priority.
b. Audible alarm duration (none, 10 seconds, 20 seconds, continuous).
c. Audible alarm rate (slow-medium-fast).
d. Historically archived (yes or no).
e. Alarm printed, with printer ID.
f. Associated coloration.

E. Time of Day Scheduler

1. Time of day schedules shall be created and modified in a graphic display window. A complete week's schedule shall be displayed on a single screen, with individual inputs for each of the seven days, and with the capability of multiple start/stop times per day. Holiday and "special day" inputs shall allow alternate schedules on these user-defined days. A calendar shall be included to allow time of day scheduling one year in advance.
2. Each schedule shall be able to control up to 60 points.
3. Override capability for individual command points shall be provided. Overrides shall be capable of being entered up to one week in advance.
4. All schedules and override requests shall be automatically transferred to the DDC panels and executed by the DDC panels.
5. An editing function shall be provided to allow one day's schedule to be copied to the next day, or to allow one system's entire schedule to be copied to another system, etc.
6. The Time of Day Scheduler shall work closely with the optimum start/stop programs resident in the DDC panels, as well and other application programs. For example, once the desired occupancy time is defined by the Time of Day Scheduler, the optimum start program shall calculate the time at which the HVAC system must start to attain the desired space temperature at occupancy time.

F. Reports

1. Standard Reports: Standard reports shall be provided which shall be operator selectable to appear on the Operator Workstation, any selected printer or both. A "terminate report" command shall be available to allow the operator to stop any report in the process of being printed. The following standard preformatted reports shall be provided for operator selection:

a. Point summary reports shall be available at any penetration level (facility, building, area, system) and shall include only points at and below that level. Point summary reports shall include the current value/status and condition, and system and point descriptors for all points. Point summary reports shall be selectable for all points, only those points in alarm, fixed points, disabled points, locked out points, locked out and in alarm points, analog input or output points, digital input or output points. All reports shall be capable of being scheduled to run at a specific time and/or interval via an operator function supported by necessary data entry templates and/or interactive prompts.
b. Trend reports shall allow the operator to randomly select logical arrays of points to be recorded at selectable time intervals. It shall be possible to assign up to six variables to each trend report. The format, headers, footers, and calculations shall be selectable by the operator. The trend report shall be stored to disk and shall be capable of being subsequently displayed and/or printed by the operator.
c. Alarm and run time reports shall be automatically issued to assigned printers immediately upon occurrence, and shall consist of the point descriptor, the status or value of the point with engineering unit, the time and date, and an action taking alarm message.

d. The user shall be provided with a command trace feature selectable on a per point basis allowing the archiving of all commands issued to each point. The archived trace shall include the command, the command source, the point ID, and the time and date. Command trace reports shall be output upon operator demand.

2. Custom Reports: A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only. Custom reports shall be scheduled or requested manually. Microsoft Excel shall be provided and fully integrated with the BAS database, and available to the user.

G. Graphic Generation Software

1. An on-line graphic development facility to allow the operator to develop new graphic displays or modify existing graphic displays, and to assign and position any array of points within each graphic display.
2. All graphic displays shall be generated on-line through the graphic generation software package at the Operator Workstation. Graphic display generation shall not require taking the Operator Workstation off-line and shall not interfere with point archiving or alarms.
3. Graphics shall be created through use of the mouse and keyboard.
4. Basic drawing functions shall include, as a minimum, freehand, lines, boxes, circles, arcs, ellipses. Text shall have multiple fonts and sizes. All symbols shall be capable of being moved, rotated, flipped, and scaled in all directions. Crosshairs, dimensions, and grids shall be available for developing accurately scaled drawings.
5. A standardized graphic library of HVAC and automation symbols shall be provided, and shall include fans, control valves, motors, chillers, standard ductwork diagrams, dampers, etc. In addition, the user shall have the capability to create custom symbols and store them in the graphic library.
6. The system shall provide expansion to a minimum of 500 graphic displays.

H. Custom DDC Programming Software

1. Text Programming Mode

a. Full screen text editor for creating new custom programs or editing existing programs. Programs shall be for use within the DDC panels. Text editor shall provide standard word-processing functions such as adding, modifying, or deleting letters, words or full lines, search and replace function, copying blocks of text, etc.
b. The operator shall be capable of inserting comments at any point within the program code to explain the objectives of the program and to clarify the code.
c. The operator shall be capable of archiving program segments for use in creating new custom control programs.
d. A library of standard DDC control algorithms shall be provided as program code archived modules to aid the operator in developing new control programs. These archived modules shall contain embedded comments to allow the operator to understand the objective of the control algorithms as well as the function of each line of the program code. The following algorithms shall be provided in the library, as a minimum: Proportional (P) control, Proportional-Integral (PI) control, Proportional-Integral-Derivative (PID) control, Adaptive Control (Self Tuning), Sequence, Reversing, Ratio, Time Delay, Time of Day, Highest Select, Lowest Select, Analog Controlled Analog Output and Digitally Controlled Analog Output.

I. System Management Software

1. Complete utilities necessary for management of the network of DDC panels and devices.
2. Multiple dynamic graphic displays showing each DDC panel, Operator Workstation peripheral, and communication links. Clicking on any device shall start an interactive dialogue allowing the user to observer the device status and to select device management options. Each device shall also be provided with an English descriptor of up to 60 characters. Devices in a failed or non-responsive mode shall show up distinctly in the system graphic displays.
3. Provide software to execute and observe diagnostics of any remote device connected to the communication network and the ability to deactivate and restart the device.
4. The operator shall be provided with the ability to override the use of a portable operators unit on any remote DDC panel.

J. Third-Party Software Compatibility

1. The system must be capable of running standard, off-the-shelf, MS-DOS compatible software packages concurrently with the real time system.
2. The system shall include a windowing feature to allow the operator to monitor the real time system and use third party software simultaneously.

2.9 AIRFLOW MEASURING PROBES – DUCT MOUNTED

A. Duct airflow measuring probes shall contain multiple total and static pressure sensors located along the exterior surface of the probe, designed to compensate for non-axial or turbulent flow.

B. Thermal Dispersion type technology may be used in-lieu of static pressure measurement.

C. Probes shall be constructed of extruded aluminum. Probes shall be provided with mounting plate, gasket, and static and total pressure fittings. Probe and mounting hardware shall facilitate easy removal and reinstallation of the probes.

D. The number of sensors on each probe, and the quantity of probes provided at each location, shall comply with ASHRAE standards for duct traversing. Multiple probes provided at a single location shall be interconnected external to the duct to produce an average signal.

E. For each airflow measurement location, the measured velocity pressure shall have accuracy within ± 2% of the full scale throughout the velocity range of 300-4000 fpm.

F. Each airflow measurement location shall be provided with an air volume gauge, dial and pointer type with diaphragm element. Black letters on white background, 4" diameter, with scale calibrated to permit direct reading of the airflow (in cfm) of the connected airflow measuring station. LCD readout with associated transmitter is acceptable.

G. Manufacturers:

1. Air Monitor Corporation.
2. Farr.
3. Ultratech Industries, Inc.
4. Brandt.
5. Tek-Air Systems, Inc.
6. Ramsey Ventures.

7. Ebtron.

2.10 AIRFLOW MEASURING STATIONS – LOW VELOCITY OA FLOW

A. Airflow measuring station with thermal dispersion type technology utilizing perimeter chamber with array of inlet ports to produce an overall average airflow rate shall be a preassembled unit including casing with connecting flanges, fabricated to the duct size.

B. Airflow measuring station shall have a galvanized steel casing (or stainless steel if manufacturer's standard) and the entire assembly shall be fabricated to withstand the maximum pressures and velocities for the application.

C. Probe type units shall be constructed of extruded aluminum and the number of sensors on each probe, and the quantity of probes provided at each location, shall comply with ASHRAE standards for duct traversing. Multiple probes shall be interconnected external to the duct to produce an average signal.

D. Perimeter chamber type units shall direct air through the mass airflow sensing probe.

E. For each airflow measurement location, the measured airflow shall have accuracy within ± 2% of the full scale throughout the velocity range of 0-4000 fpm.

F. Associated transmitter at each airflow measurement location shall be provided with LCD readout to indicate airflow (in CFM) of the overall airflow measuring station.

G. Manufacturer:

1. NJK Precision Air Flow Measurement Products.

2.11 CONTROL AND INSTRUMENTATION TUBING

A. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.

1. Fittings: ANSI/ASME B16.22, wrought copper.
2. Joints: ANSI/ASTM B32, 95-5 tin antimony.

B. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.

1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
2. Joints: Ball Sleeve compression type.

C. Polyethylene Tubing: Black, UL 1820 flame and smoke retardant where exposed in an air plenum, virgin polyethylene, conforming to modified ASTM D1693 test. All non-metallic tubing shall be minimum 1/4" O.D.; micro-sleeve is not acceptable.

1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
2. Joints: Compression or barbed type.

2.12 CONTROL VALVES AND VALVE OPERATORS

A. Pressure Dependent Characterized Ball Valves (2-way & 3-way):

1. Up to 2 inches: Bronze body with screwed ends, stainless steel or chrome plated brass ball, characterizing disc, stainless steel or brass stem, and resilient reinforced Teflon seats.
2. Manufacturers:

a. Belimo.
b. Bray / Delta Control Products.
c. Honeywell.
d. Schneider Electric Controls.
e. Johnson Controls.
f. Siemens

B. Globe Valves (2-way & 3-way):

1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, single seated, screwed ends with backseating capability, repackable under pressure.
2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc, repackable under pressure.
3. Valve stem packing shall be tetrafluorethylene, spring loaded and self-adjusting. Packless construction is acceptable.
4. Manufacturers:

a. Belimo.
b. Bray / Delta Control Products.
c. Dodge Engineering & Controls, Inc.
d. Honeywell.
e. Schneider Electric Controls.
f. Johnson Controls.
g. Siemens.

C. Electric Operators:

1. Operators shall be electronic type to accept signals from direct digital controller or modulating thermostat for proportional control.
2. Valves shall spring return to normal position as indicated. Terminal unit tempering coil control valve operators are not required to be spring return.
3. Select with sufficient shut-off power for system pressure and highest operating torque, and torque requirements of valves which may stick because of infrequent use.
4. Select to provide smooth proportioning control under operating conditions normal to the system.

D. Hydronic Systems:

1. Valve minimum pressure rating shall meet or exceed the system minimum pressure rating as noted for each system in Division 20 Section “Valves,” and in Division 23 Section “Hydronic Piping.”
2. Valve minimum temperature ratings shall be 250 deg F.
3. For globe valves: Replaceable plugs and seats of stainless steel or brass, selected for maximum lift under application conditions.

4. Two-way and three-way valves shall have equal percentage characteristics. Size two-way valve operators to close valves against pump shut off head.
5. Pressure independent control valves shall be used for 2-way applications unless otherwise indicated. Select to achieve scheduled flow rate of the associated heat transfer device. If the scheduled flow rate is too high to achieve with one valve, provide multiple valves sized at flow divided equally of the scheduled flow rate and control all valves in unison - coordinate control valve quantity and the need for parallel piping of control valves with mechanical contractor.
6. Pressure Drop for pressure dependent characterized ball and globe valves: Select Control valves that result in a pressure drop at or as close as possible to scheduled information. If not scheduled, primary HVAC equipment and terminal equipment control valves shall be selected for a pressure drop close as possible to 11.5 feet of head (5 psig). TC Contractor shall use control valves that meet the pressure drop requirements from manufacturers listed above.

E. General Service Solenoid Valves:

1. Solenoid valves for finned tube, radiant ceiling or wall panels, and unit heaters shall be 24 VAC, electric-type, for two-position (on/off) operation.

F. Natural Gas Solenoid Shutoff Valves:

1. Operation: Direct acting, electric solenoid operated, gas shutoff valve rated to be energized open when in service and closed (de-energized) when the EPO pushbutton is activated. Select valve solenoid coil electrical characteristics based on circuit power being provided. Valve shall be UL recognized component to Standard 429 – Electrically Operated Valves.
2. Description:

    a. Action: Normally closed – energize to open.
    b. Sizing: To close against the system pressure at “line-size.”
    c. Coordinate pipe connection style with the installation contractor.
    d. Heavy-duty assembly.
    e. Body: Brass for copper pipe and stainless steel for ferrous pipe.
    f. Seats and Discs: NBR or PTFE.
    g. Solenoid Enclosure: NEMA 250, Type 4.

3. Manufacturers:

    a. ASCO 2/2 Series Model 200-series Modular.
    b. Honeywell V4295 Series.

2.13 DAMPERS - AUTOMATED

A. Performance: Test in accordance with AMCA 500.

B. Frames: Galvanized steel, minimum 16 gauge, minimum 2 inches in width, welded or riveted with corner reinforcement for 12 gage structural equivalence.

C. Blades: Galvanized steel, minimum 14-gauge, maximum blade size 8 inches wide, 60 inches long, attached to minimum 1/2-inch shafts. Dampers which are required to have a static pressure rating over 4-inch W.G. shall have minimum 3/4-inch solid shafts.

D. Blade Seals: Synthetic elastomeric or Neoprene, mechanically attached, field replaceable.

E. Jackshafts (where required): Minimum 1/2-inch galvanized steel.

F. Jamb Seals: Stainless steel.

G. Bearings: Oil impregnated sintered bronze or lubricant free, solid stainless steel. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.

H. Linkages: Accessible for maintenance. Linkages may be located in airstream. Linkages located in damper frame shall be external to the duct, accessible for maintenance. Linkages located in the airstream shall be zinc plated.

I. Leakage: Less than 8 CFM per square foot based on 4 inches W.G. pressure differential.

J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4" W.G.

K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.

L. Temperature Limits: -40 to 200 deg F.

2.14 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR - AUTOMATED

A. Performance: AMCA certified for Air Performance and Air Leakage.

B. Frames: Extruded aluminum, .080-inch thickness minimum, 4 inches deep minimum, thermally broken, and insulated with polystyrene or polyurethane foam insulation.

C. Blades: Extruded aluminum, internally insulated, and thermally broken. Maximum blade size 8 inches wide, 60 inches long.

D. Shafts: Minimum 7/16 inch hexagonal or square corrosion resistant zinc plated steel.

E. Blade Seals: Extruded EPDM, silicone, or synthetic elastomeric, mechanically attached.

F. Jamb Seals: Silicone, or synthetic elastomeric, mechanically attached.

G. Bearings: Dual bearing assembly of durable synthetic polymer resulting in no metal-to-metal contact. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.

H. Linkage: Linkage shall be installed in the frame side and shall be constructed of aluminum and/or corrosion resistant zinc plated steel.

I. Leakage: Less than 3 CFM per square foot at 1-inch W.G. pressure differential at minus 40 deg F.

J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4 inches W.G.

K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.

L. Temperature Limits: Minus 40 to 155 deg F.

M. Manufacturers:

1. Greenheck ICD-45.
2. Ruskin TED50 Series.
3. Tamco Series 9000 BF.

2.15 DAMPER OPERATORS - ELECTRIC

A. Electric damper motor shall be 24 or 120 volt two-position or modulating as required with spring return type and sized to operate the damper with sufficient reserve power for smooth operation from full close to full open and tight shut-off. Damper motor shall have "O ring" gaskets for weatherproof operation.

B. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide sufficient number of operators such that one operator does not operate more than the maximum square footage of damper area as recommended in standard catalog of manufacturer.

C. Manufacturers:

1. Belimo.
2. Delta Control Products.
3. Honeywell.
4. Schneider Electric Controls.
5. Johnson Controls.
6. Siemens.

2.16 DIFFERENTIAL PRESSURE SWITCHES

A. Shall provide electrical switching action upon a sensed pressure differential increase between two sensed points. Sensitivity shall be suitable for the application. Setpoint shall be adjustable over the full range of the device. Switching action shall open or close two independent single-pole, double-throw (SPDT) switches. Electrical switch rating shall be based on the application and circuit voltage

B. Pressure rating of switch/connecting tubing and reset type:

1. Filter pressure drop - Rated for 2 inches w.g. Provide automatic reset type.
2. Duct static pressure - Rated for 10 inches w.g. Provide manual reset type when used for high limit cutout safety.

2.17 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK

A. Electrical accessories such as relays, switches, contactors and control transformers shall meet the requirements of the Division 26 Specifications of respective project.

B. Electrical wiring and conduit shall meet the requirements of the Division 26 Specifications.

C. All control wiring in mechanical rooms and any other exposed areas shall be run in conduit. Low voltage temperature control wiring in concealed accessible locations (i.e., above lay-in ceilings), as well as low voltage temperature control wiring within partitions, may be run using plenum rated cable, neatly tie-wrapped and fastened to the building structure (not to ceiling or ceiling support wires).

D. Conduits carrying control wiring shall be sized for a maximum fill of 40% of capacity.

E. Where raceway is required, two separate raceway systems shall be provided: one for A.C. wiring and the other for D.C. wiring.

F. Data transmission cabling and equipment grounding procedures shall meet the latest FCC guidelines for electromagnetic field generation.

G. All control wiring sizes and types shall meet or exceed the equipment manufacturer's recommendations.

H. TC Contractor shall provide 24V power supply transformers for TC Contractor provided controllers. Maximum Transformer circuit for controls shall be 100VA serving controllers within mechanical room control panels or for remote terminal unit controllers served from common 24V power supply circuit. Transformers shall be located within enclosures provided by TC Contractor.

2.18 EMERGENCY POWER-OFF (EPO) PUSH-BUTTON

A. ADA compliant, push-button switch with clear cover to prevent inadvertent closure. Push-to-activate push-button, and providing two SPDT contacts rated 10 Amps at 120 VAC.

B. Manufacturers:

1. Safety Technology International – model SS-2212PO
2. Alarm Controls Corporation – model ADC-100.

2.19 GAS DETECTION MONITORING SYSTEM (CO & NO2)

A. UL approved Control Panel shall be capable of monitoring carbon monoxide and nitrogen oxide sensors via communication bus. The control panel shall indicate exact gas concentrations and location for each sensor with information displayed on LCD display. Controller shall be capable of handling 32 sensor inputs. Two alarm levels shall be displayed for each sensing point. Normal and failure indications shall be provided for each sensing point.

B. Setpoint adjustments shall be capable from a local keypad.

C. Control panel shall have two internal DPDT relays that can be programmed for alarm levels. A local strobe shall be provided and connected to 2nd level general alarm. Specific sensor in alarm shall be indicated on LCD display.

D. Control panel shall be capable of controlling 2 remote alarm relay modules based on adjustable setpoints.

E. Control Panel shall include audible alarm, 65 dBA at 3 ft.

F. Control Panel shall be equipped with power supply module to supply power to all connected sensor/transmitters associated with panel

G. Wall mounting brackets shall be provided.

H. Control Panel Manufacturer: Vulcain, model VA-201C control panel with VA-201TA power supply transformer. Alternate systems subject to approval by engineer.

I. UL approved carbon monoxide sensor/transmitter shall be capable of detecting carbon monoxide (CO) at a radius of 50 ft. Detection Range shall be 0-500ppm at 3% accuracy. Sensor must compensate for variations in humidity and temperature to maintain a high level of accuracy. Local audible alarm (65 dBA at 3 ft) shall be provided on sensor/transmitter, activated upon 2nd high alarm level which shall be adjustable at control panel. Sensor shall be capable of operating in environmental conditions of 5-90% relative humidity and 32 to 100 deg F temperatures. Sensor Manufacturer: Vulcain, model VA-201T-Q1-CO. Alternate systems subject to approval by engineer.

J. UL approved nitrogen dioxide sensor/transmitter shall be capable of detecting nitrogen dioxide (NO2) at a radius of 50 ft. Detection Range shall be 0-10ppm at 3% accuracy. Sensor must compensate for variations in humidity and temperature to maintain a high level of accuracy. Local audible alarm (65 dBA at 3 ft) shall be provided on sensor/transmitter, activated upon 2nd high alarm level which shall be adjustable at control panel. Sensor shall be capable of operating in environmental conditions of 5-90% relative humidity and 32 to 100 deg F temperatures. Sensor Manufacturer: Vulcain, model VA-201T-Q1-NO2. Alternate systems subject to approval by engineer.

K. Calibration Kit with carrying case shall be provided for carbon monoxide sensors. Two 100-liter tanks shall be provided. Manufacturer: Vulcain, model SKCOQ1. Alternate systems subject to approval by engineer.

L. Calibration Kit with carrying case shall be provided for nitrogen oxide sensors. Two 50-liter tanks shall be provided. Manufacturer: Vulcain, model SKNO2Q1. Alternate systems subject to approval by engineer

M. Sensor/transmitter guards: Provide wire guards for all CO and NO2 sensor locations.

2.20 LIMIT SWITCHES

A. Oil tight type with operator as required providing required function. Limit switches used on dampers should be set at approximately 75% of full stroke.

B. Manufacturers:

1. Allen-Bradley.
2. General Electric.
3. Square D.
4. Westinghouse.
5. Micro-switch.

2.21 LOCAL AND AUXILIARY CONTROL COMPONENT ENCLOSURE PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, pushbuttons and switches flush on cabinet panel face, or as detailed on drawings. Provide panel with locking door.

B. ANSI/NEMA 250, general purpose utility enclosures with enameled finished face panel, or as indicated on the drawings.

C. Panels shall be sized for a maximum fill of 50% capacity and shall not be smaller than 24" X 24".

2.22 REFERENCE PROBE - DUCT STATIC PRESSURE

A. Duct static pressure probe shall be capable of static pressure measurement with bi-directional flow in a duct, plenum or air handling unit. Probe shall have minimum 4" insertion depth, shall compensate for total pressure error, and shall provide an accurate, repeatable and stable static pressure value with a maximum flow of 4000 fpm.

B. Probe shall be constructed of aluminum, with mounting flange suitable for round or flat duct surfaces. Probe shall have static pressure signal fitting.

C. Manufacturers:

1. MAMAC # A-520.
2. Dwyer # A-305.
3. Tek-Air # T-SPP 7100/7200.

2.23 REFERENCE PROBE - INDOOR STATIC PRESSURE

A. Indoor pressure reference probe shall be a shielded static pressure sensor suitable for flush mounting in the ceiling, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, control tubing take-off fitting, and brush finish on exposed surface. Probe shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 fpm from a radial source.

B. Manufacturers:

1. Air Monitor Corporation.
2. Tek-Air.

2.24 REFERENCE PROBE - OUTDOOR STATIC PRESSURE

A. Outdoor pressure reference probe shall be constructed of anodized aluminum, with control tubing take-off fitting, which shall be capable of sensing the outside ambient air pressure to within 2% of the actual value when subjected to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal.

B. Manufacturers:

1. Air Monitor Corporation.
2. Tek-Air.

2.25 THERMOMETERS - AIRSTREAM

A. ASTM E1, 4 inch diameter dial in stainless steel or drawn steel with enamel finish case, vapor or liquid actuated with brass or copper bulb, copper or bronze braided capillary of sufficient length and with necessary bulb supports within airstream, white with black markings and black pointer, unbreakable lens, 1 percent scale accuracy. Maximum scale divisions shall be 2 deg F. Select scale ranges such that all expected temperatures are within the range but such that the range does not extend beyond the extremes more than 25 degrees.

B. Manufacturers:

1. Trerice.
2. Weksler.
3. Marsh.
4. Honeywell.
5. Schneider Electric Controls.
6. Johnson Controls.
7. Siemens.

2.26 THERMOSTATS – ELECTRONIC & ELECTRIC

A. Line Voltage Room Thermostats: Adjustable single setpoint with exposed setpoint indicator and exposed thermometer for a range of 55 deg F to 85 deg F with maximum dead band of 1-1/2 degrees F, and locking cover. Contacts shall be rated for load, single-pole or two-pole as required. Provide with integral manual On/Off/Auto selector switch where indicated on control details. Power Requirement: 24 V, ac or 120 V, ac as required.

B. Room Thermostat Accessories:

1. Thermostat Covers: Manufacturers standard with finish as selected by Architect.
2. Insulating Bases: Provide one inch insulating base for thermostats located on exterior walls.
3. Adjusting Key: As required for device.

C. Electric Low Limit Duct Thermostat (freezestat): Snap acting which trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint, fixed 5 deg F differential, range 30 deg F to 60 deg F, requiring minimum 20 feet length of bulb. Manual-reset unless indicated on drawings to be auto-reset type. Provide one thermostat for every 20 sq ft of coil surface. Switch shall be UL listed and rated for 10 amps at 120 VAC. Provide additional switch or contacts for connection to monitoring system.

D. Electric; strap-on piping type thermostat for control of fans with hot water heating coils. Operation of fan to be Off when temperature is below setpoint as required per control details. Contacts shall be rated for load. Provide transformer for 24 V, ac or 120 V, ac duty as required

E. Manufacturers for listed Thermostat Types:

1. Honeywell International, Inc.
2. Johnson Controls, Inc.
3. Schneider Electric USA, Inc.
4. Siemens Industry, Inc.; Building Technologies Division.
5. White-Rodgers Div.; Emerson Electric Co.

PART 3 - EXECUTION

3.1 INSTALLATION - CONTROL SYSTEMS

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of temperature sensors, thermostats and other exposed control sensors with plans and room details before installation. Locate room temperature sensors and thermostats 48 inches above floor unless noted otherwise.

C. The location of all control-related items to be mounted on the exterior of the building must be approved by the Architect prior to installation. Indicate proposed locations on the shop drawings.

D. Caulk both sides of damper frames to duct walls to prevent leakage between damper frame and duct.

E. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. Sensors used for closed loop control must be connected to the same DDC controller as the associated output signal.

F. Provide conduit and electrical wiring where required.

G. All wiring in altered and unaltered areas shall be run concealed. "Wiremold" in finished areas shall be allowed when wiring cannot be run concealed in walls or partitions. Minimize “wiremold” routing.

H. Splicing of DDC sensor cabling at junction boxes shall not be acceptable.

I. All equipment which has moving parts and is remotely started by the control system shall be provided with warning labels no less than 2 inches in height, and in bright warning color, stating that the equipment is remotely started by automatic controls. Such labels shall be posted clearly in the area of any moving parts, such as belts, fans, pumps, etc.

J. Coil and conceal excess capillary on remote element instruments.

K. Install thermometers in air duct systems on flanges.

L. Install all gauges and thermometers in locations where they are easily read from normal floor level. Provide tubing or wiring as required.

M. Locate all control components and accessories such that they are easily accessible for adjustment, service and replacement.

N. Locate, size and support sensing elements in airstreams so that they properly sense the representative condition. Controlling, transmitting, and indicating elements shall be located to sense the average condition. Safety elements shall be located to sense the extreme condition.

O. Locate and size sensing elements in liquid lines so that they are in moving liquid and not in stagnant or turbulent locations. Wells shall not obstruct the flow of the liquid being measured. Pipes one inch and smaller shall be increased at least one pipe size at the point of insertion.

P. Locate pressure sensing taps in liquid lines in straight runs of pipe with at least 10 pipe diameters of straight pipe both upstream and downstream of pressure tap. Provide a shut-off cock in sensing line at each pressure tap.

Q. Install pressure sensing elements in ducts and casings with clean, sharp taps to accurately read true static pressure, avoiding velocity influence and turbulence.

R. Locate, support and install all control components and accessories so that they will not be subject to vibration, excessive temperatures, dirt, moisture or other harmful conditions beyond their rated limitations.

S. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight. Provide brackets for devices to be located on insulated surfaces so as to clear the finished surface of the insulation and to avoid puncturing the vapor seal.

T. Provide all necessary relays, switches, linkages, control devices, accessories and connections as required for a complete and operational control system as specified herein and shown.

U. All electric valve and damper operators shall be capable of moving from full closed to full open, or vice versa, within 120 seconds.

3.2 TC CONTRACTOR DESIGN & INSTALLATION COORDINATION MEETINGS

A. Temperature Controls Shop Drawing Pre-Submittal Meeting: TC Contractor's option to schedule a meeting at the Engineer's Office to review project design documentation for clarification purposes to aide in the TC Contractor development of TC/BAS shop drawings. For simple clarification items, TC Contractor may contact Engineer via telephone to discuss. For project scope questioning items, TC Contractor shall utilize the formal Request of Information (RFI) process.

B. Temperature Controls Shop Drawing Submittal Meeting: Project Design Engineer's option to schedule a meeting at the Engineer's Office to review the TC Contractor's formally submitted drawings to address Engineer's comments and concerns that indicate TC Contractor's shop drawings vary from project design intent. This meeting can be avoided if TC Contractor's shop drawing submittal is complete and Engineer is confident that documents are going to lead to an installation that meets project design intent.

C. Temperature Controls Installation Technician Meeting: Project Design Engineer's option to schedule a meeting at the project site to meet and discuss project expectations with the TC Contractor's field installation technician and/or project manager. Discussion may include

1. Shop drawing review comments to ensure installation technician has the most up-to-date TC submittal.

2. Graphics generation requirements including special Owner requirements and schedule for completion.
3. Owner training agenda and scheduling.
4. TC/BAS system acceptance procedures.

3.3 IDENTIFICATION AND MARKING

A. All sensors, relays, switches, etc. shall be marked with the same identification number as used on the as-built shop drawings. Use Brother P-touch label maker or similar with black text on clear or white super adhesive tape. If label applied in wet environment, spray label with clear enamel for waterproofing.

B. Wire shall be color coded according to functional use. Identify color coding format on record drawings.

C. Identify each wire as to ID number at each controller termination, field device termination or on the field device.

D. All control panels and auxiliary enclosures shall be supplied with engraved phenolic nameplate permanently attached on the front exterior with panel identification to match details of temperature control submittals and include system(s) served and area(s) served on the labeling. Include labeling near 120VAC terminations within panel identifying power source panel ID and specific circuit breaker used.

3.4 GRAPHIC DISPLAY GENERATION

A. Provide the following graphic displays as a minimum at the operator interface, arranged in logical penetration paths:

1. Overall floor map layout.
2. Floor plans for each floor or building zone within the building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.
3. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:

    a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
    b. System name.
    c. Area served.
    d. Present value or status of all inputs, along with present setpoint.
    e. Present percent open for each damper, valve, etc. based on commanded position.
    f. Reset schedule parameters for all points, where applicable.
    g. Present occupancy mode.
    h. Present economizer mode, where applicable.
    i. Present outside air temperature.
    j. Associated space conditions and setpoints, where applicable.
    k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).

l. Color coding to indicate normal and abnormal values, alarms, etc.

4. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc.) shall be provided. Graphic display of output point auto or manual override status shall be provided.
5. Sequence of operation in written (text) format for each HVAC system.
6. Overall BAS system schematic.
7. System management graphic for each network device and/or DDC controller.

3.5 OWNER INSTRUCTION AND TRAINING

A. Provide a minimum of forty (40) hours of combined on-site and classroom instruction and training to the Owner on the operation of the control systems for the initial installation.

B. Instruction and training shall be performed by a competent Contractor representative familiar with the control systems operation, maintenance, and calibration.

C. Training shall take place after check, test, start-up of temperature controls system at a time mutually agreed upon by the Owner and Contractor.

D. Provide 5 sets computer training & tutorial material on USB Flash Drives describing operator's BAS graphical interface capabilities and functions.

E. Provide 5 sets of literature pertaining to the operation and maintenance of the DDC system components provided.

3.6 CALIBRATION AND START-UP

A. After installation and connection of control components, test, adjust and re-adjust as required all control components in terms of function, design, systems balance, and performance. Make systems ready for environmental equipment acceptance tests.

B. After environmental equipment has been accepted and after the systems have operated in normal service for two weeks, check the adjustment on control components and recalibrate where required. Components not in calibration shall be recalibrated to function as required or shall be replaced. Control devices, linkages, and other control components shall be calibrated and adjusted for stable and accurate operation in accordance with the design intent and to obtain optimum performance from the equipment controlled. Cause every device to automatically operate as intended to ensure its proper functionality.

3.7 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration as indicated in this section, the Architect shall be requested in writing to inspect the satisfactory operation of the control systems.

B. Demonstrate operation of all control systems, including each individual component, to the Owner and Architect.

C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect for inspection and approval.

D. After all items on the punch list are corrected and formal approval of the control systems is provided by the Architect, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

END OF SECTION 230933

SECTION 231123 - FUEL GAS 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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes facility fuel gas piping.

B. Service meter assemblies will be furnished and installed by utility company.

1.3 DEFINITIONS

A. Gas Main: Utility's natural gas piping.

B. Gas Distribution: Piping from gas main to individual service-meter assemblies.

C. Service-Meter Assembly: Piping, valves, service regulator, service meter, and specialties.

D. Point of Delivery: Piping outlet from service-meter assembly.

E. Fuel Gas Piping: Piping that conveys fuel gas from point of delivery to fuel gas utilization devices.

F. PE: Polyethylene.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: Performance requirements are scheduled on the Drawings.
2. Exception: Fuel Gas Piping Installed within Ceilings Used as Plenums: 150 psig.

1.5 SYSTEMS DESCRIPTIONS

A. Fuel gas piping system materials are scheduled on the Drawing.

1.6 ACTION SUBMITTALS

A. Product Data: For the following:

1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.

1.7 INFORMATIONAL SUBMITTALS

A. Shop Drawings: For fuel gas piping. Include plans and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.

B. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

1.8 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For natural gas specialties and accessories to include in operation and maintenance manuals.

1. Lubricated Plug Valves: Installation, operation, lubrication, and leak testing procedures.

1.9 QUALITY ASSURANCE

A. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

B. 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.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.11 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Gas System Pressure: Not more than 5.0 psig.

C. Design values of fuel gas supplied for these systems are as follows:

1. Nominal Heating Value: 1000 Btu/cu. ft.
2. Nominal Specific Gravity: 0.6.

1.12 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 requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

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 BLACK STEEL PIPE AND FITTINGS

A. Black Steel Pipe: ASTM A 53/A 53M or ASTM A 106; Type E or S; Grade B; Schedule 40. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.3 PE PIPE AND FITTINGS

A. Manufacturers:

1. Chevron Phillips Chemical Company LLC; Performance Pipe Division; Driscopipe and Driscoflex.
2. Endot Industries, Inc.
3. Mexichem Datacom & Infrastructure; DuraLine; PolyPipe.
4. Oil Creek Plastics.

B. PE Pipe: ASTM D 2513, PE2708 or PE4710, SDR 11.

1. PE Fittings: ASTM D 2683, socket type or ASTM D 3261, butt type with dimensions matching ASTM D 2513, SDR 11, PE pipe.

C. Transition Fittings: Manufactured pipe fitting with one PE pipe end for heat-fusion connection to PE pipe and with one ASTM A 53/A 53M, Schedule 40, steel pipe end for threaded connection to steel pipe.

D. Service-Line Risers: Manufactured PE pipe fitting with PE pipe inlet for heat-fusion connection to underground PE pipe; PE pipe riser section with protective-coated, anodeless, steel casing and threaded outlet for threaded connection to aboveground steel piping.

2.4 PIPING SPECIALTIES

A. Flexible Connectors: ANSI Z21.24, copper alloy.

B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

C. 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.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.5 JOINING MATERIALS

A. Refer to Division 20 Section “Basic Mechanical Materials and Methods.”

2.6 SPECIALTY VALVES

A. Valves, NPS 3 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 4: Threaded ends according to ASME B1.20.1 for pipe threads; or flanged ends according to ASME B16.5 for steel flanges.

C. Valves, NPS 6 and Larger: Flanged ends according to ASME B16.5 for steel flanges.

D. Natural Gas Valves, NPS 3 and Smaller: Use the following:

1. Ball Valves: Bronze or brass body with AGA or CSA stamp, UL listed or FM approved for service, with chrome-plated brass ball and lever handle; 125-psig minimum pressure rating.

a. Manufacturers:

1) Apollo Valve; Conbraco Industries, Inc.
2) Jomar International Ltd.
3) Legend Valve and Fitting, Inc.
4) Milwaukee Valve Company.
5) NIBCO INC.
6) Watts Water Technologies, Inc.; Watts Regulator Co.

b. Tamperproof Feature: Include design for locking.

E. Natural Gas Valves, NPS 4: Use any of the following:

1. Cast-Iron, Eccentric Plug Valves:

a. Manufacturers:

1) Homestead Valve; a division of Olson Technologies, Inc.; Keycentric Series 300.
2) Milliken Valve Company; Mueller Water Products; Model 625.

b. Approvals: UL approved.
c. Body: Cast iron, complying with ASTM A 126, Class B.
d. Plug: Bronze or nickel-plated cast iron.
e. Stem Seal: Compatible with natural gas.
f. Resilient Plug Seal: Compatible with natural gas.
g. Operator: Square head or lug type with tamperproof feature where indicated.
h. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
i. Pressure Class: 125 psig.

2. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

a. Manufacturers:

1) Flowserve Nordstrom.
2) Homestead Valve; a division of Olson Technologies, Inc.
3) R&M Energy Systems, a Unit of Robbins & Myers, Inc.; Resun.

b. Body: Cast iron, complying with ASTM A 126, Class B.
c. Plug: Bronze or nickel-plated cast iron.
d. Seat: Coated with thermoplastic.
e. Stem Seal: Compatible with natural gas.
f. Operator: Square head or lug type with tamperproof feature where indicated.
g. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
h. Pressure Class: 125 psig.

F. Natural Gas Valves, NPS 6 and Larger: Use any of the following:

1. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

a. Manufacturers:

1) Flowserve Nordstrom.
2) Homestead Valve; a division of Olson Technologies, Inc.
3) R&M Energy Systems, a Unit of Robbins & Myers, Inc.; Resun.

b. Body: Cast iron, complying with ASTM A 126, Class B.
c. Plug: Bronze or nickel-plated cast iron.
d. Seat: Coated with thermoplastic.
e. Stem Seal: Compatible with natural gas.
f. Operator: Square head or lug type with tamperproof feature where indicated.
g. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
h. Pressure Class: 125 psig.

2. Class 150, Full-Port, Carbon-Steel Ball Valves:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Apollo Valve; Conbraco Industries, Inc.; 88A-200-UL Series.
2) Metso Automation; Jamesbury Valves.

b. UL listed.
c. Split-body construction.
d. Chrome-plated carbon steel ball.
e. Reinforced PTFE seats.
f. Lever actuation.

2.7 PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.

1. Manufacturers:

a. Line Pressure Regulators:

1) Elster Gas North America; Elster American Meter.
2) Fisher Controls International, Inc.; Division of Emerson Process Management.
3) Itron Gas.

2. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
3. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.
4. Service Pressure Regulators: ANSI Z21.80. Include 100-psig- minimum inlet pressure rating.
5. Line Pressure Regulators: ANSI Z21.80/GCA 6.22 or ANSI B109.4/CGA 6.18, with inlet pressure rating as scheduled on the Drawings.

a. Regulators for Generator Sets: Direct operated, fast acting type.

6. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section “Earthwork” for excavating, trenching, and backfilling.

3.2 EXAMINATION

A. Examine roughing-in for fuel gas piping system to verify actual locations of piping connections before equipment installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.4 SERVICE-METER ASSEMBLY INSTALLATION

A. Service meter assembly will be installed by the fuel gas utility company.

B. Install gas valve or plug valve and strainer upstream from each service pressure regulator.

C. Install service pressure regulators with vent outlet turned down and with corrosion-resistant-metal insect screen.

D. Install pressure gage upstream and downstream from each service pressure regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."

E. Install service meters downstream from service pressure regulators.

1. Service meters with connections larger than NPS 1 supported from piping or set on concrete bases.

3.5 SERVICE ENTRANCE PIPING

A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.

1. Exterior fuel gas distribution system piping, service pressure regulator, and service meter will be provided by gas utility.
2. Refer to Article entitled “Codes, Permits and Fees” in Division 20 Section “Mechanical General Requirements” for additional requirements.

B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Dielectric fittings are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.6 PIPING SYSTEM INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

B. 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.

C. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.

E. Concealed Locations:

1. Above Inaccessible Ceiling Locations: Gas piping with welded joints may be installed in inaccessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above inaccessible ceilings.
2. Above Accessible Ceiling Locations: Gas piping with welded joints may be installed in accessible ceiling spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above ceilings used as plenums.
3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.
4. Underground Beneath Building: Gas piping may be installed in protective conduit in accordance with Chapter “Gas Piping Installations” in the International Fuel Gas Code.
5. In Partitions: Do not install concealed piping in solid partitions, unless installed in a chase or casing.

    a. Exception: Piping passing through partitions or walls.

6. In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.

7. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

F. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

G. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

H. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

I. Connect branch piping from top or side of horizontal piping.

J. Install pressure gage upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."

K. Locate valves for easy access.

L. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

M. Install flanges when connecting to valves, specialties, and equipment having NPS 2-1/2 and larger connections.

N. Install gas valve or plug valve and strainer upstream from each line pressure regulator or appliance pressure regulator.

O. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.7 JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Use materials suitable for fuel gas.

C. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.8 POLYETHYLENE PIPE INSTALLATION

A. Install underground, PE, natural gas distribution piping according to ASTM D 2774.

B. Install underground, PE, natural gas distribution piping at entrance to and under part of building in steel piping protective conduit that is vented to outside.

3.9 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 20 Section "Hangers and Supports."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.

B. Install piping adjacent to appliances to allow service and maintenance.

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.11 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.

1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
2. Nameplates, pipe identification, and signs are specified in Division 20 Section "Mechanical Identification."
3. Trace Wire: Yellow insulated, minimum 18 AWG wire, having copper or other approved conductor, with insulation suitable for direct burial, installed adjacent to underground nonmetallic piping, with aboveground access to tracer wire at each end of pipe.

3.12 PAINTING

A. Use materials and procedures in Division 09 painting Sections.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (semigloss).
d. Color: Gray.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.13 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03.

3.14 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

C. Additional Testing: Subject welded fuel gas piping installed within ceiling spaces used as plenums to test pressure of 150 psig for a minimum of 2 hours.

D. Natural-gas piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.15 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, and maintain lubricated plug valves.

END OF SECTION 231123

SECTION 232113 - HYDRONIC 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. Division 07 Section "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
2. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
3. Division 20 Section “Mechanical General Requirements.”
4. Division 20 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
5. Division 20 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
6. Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

7. Division 20 Section "Meters and Gages" for thermometers, flow meters, flow measuring devices, and pressure gages.
8. Division 20 Section "Mechanical Identification" for labeling and identifying hydronic piping.
9. Division 23 Section "General-Duty Valves for HVAC" for general-duty gate, globe, ball, butterfly, and check valves.
10. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
11. Division 23 Section "Temperature Controls" for temperature-control valves and sensors.
12. Division 23 Section “Piping Systems Flushing and Chemical Cleaning.”
13. Division 23 HVAC water treatment sections.

1.2 PERFORMANCE REQUIREMENTS

A. Where not indicated on the Drawings, hydronic piping components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1.3 SYSTEMS DESCRIPTIONS

A. Hydronic piping system materials are scheduled on the Drawings.

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. Hydronic specialties.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Detail, at minimum 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.

B. Qualification Data: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. 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.

B. Installer Qualifications:

C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. DWV Copper Tubing: ASTM B 306, Type DWV.

C. Wrought-Copper Socket Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

E. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ASC Engineered Solutions; Gruvlok; CTS Copper System.
   b. Victaulic Company; Style 606 and Style 607.

2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40 Steel Pipe: ASTM A 53/A 53M or ASTM A 106, Type E or S, Grade A or B. Include ends matching joining method.

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125.

6. Fittings: ASTM A234 ANSI B16.9, steel butt weld to match pipe wall thickness, Class 300.
7. Flanges: Class 300 forged steel welding neck to match pipe wall thickness and valve flanges, ANSI B16.5. Orifice plate flanges shall be raised face welding neck type with ring joint gaskets and flange taps. Coordinate orifice plate flanges with orifice plate flow elements.

B. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ASC Engineered Solutions; Gruvlok; Model 7401 Rigid, Model 74 SlideLOK, and Fig. 7400 Rigidlite.
   b. Victaulic Company; Style 107 QuickVic Rigid Coupling and W07 AGS Rigid Coupling.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Gaskets: Synthetic rubber gasket of central cavity pressure-responsive design suitable for temperatures from minus 30 deg F to 230 deg F.
4. Couplings: Ductile-iron housing with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

   a. Rigid Type: To provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.

2.3 JOINING MATERIALS

A. Refer to Division 20 Section “Basic Mechanical Materials and Methods.”

2.4 VALVES

A. General Service Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC."

2.5 SPECIALTY VALVES

A. Balance Valves:

B. Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Griswold Controls.
   b. Hydronic Components, Inc. (HCi); a Jomar Group Company.
   c. IMI Flow Design; IMI Hydronic Engineering Inc.
   d. Jomar Hydronics.
   e. Macon Balancing; Tunstall Corporation.
   f. Nexus Valve.

g. PRO Hydronic Specialties, LLC.

2. Manufacturers: Subject to compliance with requirements, use products by one of the following:

a. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
b. ASC Engineered Solutions; Gruvlok; Model CBV.

3. Body: Brass or bronze, ball or plug type with calibrated orifice or venturi.
4. Ball: Plated brass, or stainless steel.
5. Plug: Resin.
6. Seat: PTFE.
7. End Connections: Threaded or socket.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. WOG Rating: Minimum 400 psig.
11. Maximum Operating Temperature: 250 deg F.

C. Combination, Balancing Valves and Flow Measuring Devices NPS 2-1/2 through NSP 4:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Griswold Controls.
b. Hydronic Components, Inc. (HCi); a Jomar Group Company.
c. IMI Flow Design; IMI Hydronic Engineering Inc.
d. Jomar Hydronics.
e. Macon Balancing; Tunstall Corporation.
f. Nexus Valve.
g. PRO Hydronic Specialties, LLC.

2. Manufacturers: Subject to compliance with requirements, use products by one of the following:

a. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
b. ASC Engineered Solutions; Gruvlok; MBV Series, CSV Series.

3. Body: Cast-iron or steel body, ball, plug, butterfly, or globe pattern with calibrated orifice or venturi.
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. WOG Rating: Minimum 200 psig.
11. Maximum Operating Temperature: 225 deg F.

D. Contractor Option for Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller: Preassembled coil hook up kits may be used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Griswold Controls.

b. Hydronic Components, Inc. (HCi); a Jomar Group Company.
c. IMI Flow Design; IMI Hydronic Engineering Inc.
d. Jomar Hydronics.
e. Macon Balancing; Tunstall Corporation.
f. Nexus Valve.
g. PRO Hydronic Specialties, LLC.

2. Manufacturers: Subject to compliance with requirements, use products by one of the following:

a. Tour & Andersson; TA Hydronics Series available through Victaulic Company of America.
b. ASC Engineered Solutions; Gruvlok.

2.6 CONTROL VALVES

A. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Temperature Controls."

B. Calibrated orifice balancing valves shall not be required on devices where pressure independent characterized control valves (PICCV's) are installed.

2.7 AIR CONTROL DEVICES

A. Manual Air Vents: Use ball-valve-type hose-end drain valves, refer to Division 23 Section "General-Duty Valves for HVAC."

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; Xylem Inc.
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. Maximum Operating Pressure: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amtrol, Inc.

b. Armstrong Pumps, Inc.
c. Bell & Gossett; Xylem Inc.
d. Taco, Inc.
e. Wessels Co.

2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
4. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
5. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch-diameter gage glass, and slotted-metal glass guard.

D. Bladder-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett; Xylem Inc.
d. Taco, Inc.
e. Wessels Co.

2. Tank: Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Combination Air and Dirt Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Spirotherm, Inc.; VDN Series.

2. Body: Fabricated steel; constructed for 150-psig maximum working pressure and 250 deg F maximum operating temperature. Separator shall have body extended below pipe connections for dirt separation and include removable lower head.
3. Air and Dirt Separation Mechanism: Internal copper core tube with continuous wound copper medium permanently attached followed by continuous wound copper wire permanently affixed .
4. Venting Chamber: With integral full port, float actuated brass venting mechanism. Include valved side tap to flush floating dirt or liquids and for quick bleeding of air during system fill.
5. Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.

6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.

2.8 HYDRONIC PIPING SPECIALTIES

A. Diverting Fittings: 125-psig working pressure; 250 deg F maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.

B. Flexible connectors and expansion fittings are specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."

1. Manufacturers:

a. Des Champs Technologies; HVAC Air Trap; P-Series, N-Series, and RLC Series.

2.9 HYDRONIC PIPING STRAINERS

A. Manufacturers:

1. Apollo Valves; Conbraco Industries, Inc.
2. Griswold Controls.
3. Keckley Company.
4. Metraflex Company.
5. Mueller Steam Specialty; a Watts Brand.
6. NIBCO, Inc.
7. Sure Flow Equipment Inc.
8. Titan Flow Control, Inc.
9. Watts.
10. Yarway; Emerson Automation Solutions.
11. ASC Engineered Solutions; Gruvlok Manufacturing (for grooved piping).
12. Victaulic Company (for grooved piping).

B. Y-Pattern Strainers, Bronze:

1. CWP: 200 psig minimum, unless otherwise indicated.
2. SWP: 125 psig minimum, unless otherwise indicated.
3. Body: Bronze for NPS 2 and smaller.
4. End Connections: Threaded or soldered.
5. Strainer Screen: Stainless steel, 40-mesh unless otherwise noted or scheduled.
6. Drain:

a. Pipe plug for sizes NPS 2 and smaller.
b. Factory-installed, hose-end drain valve for sizes NPS 2-1/2 and larger.

C. Y-Pattern Strainers, Cast and Ductile Iron:

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, 40-mesh unless otherwise noted or scheduled.
4. CWP: 200 psig minimum, unless otherwise indicated.
5. SWP: 125 psig minimum, unless otherwise indicated.
6. Drain:

    a. Pipe plug for sizes NPS 2 and smaller.
    b. Factory-installed, hose-end drain valve for sizes NPS 2-1/2 and larger.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 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 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.

M. Install piping, other than drain piping, at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC."

Q. 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.

R. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

S. Install check valves at each pump discharge and elsewhere as required to control flow direction.

T. 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.

U. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

V. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

W. Install flanges or grooved mechanical couplings in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

X. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and where 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.

Y. Identify piping as specified in Division 20 Section "Mechanical Identification."

3.2 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 20 Section "Hangers and Supports." Comply with the following requirements 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. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper 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.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 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.
7. NPS 4 to NPS 5: Maximum span, 10 feet minimum rod size, 1/2-inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.3 PIPE JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 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. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install combination air/dirt separator in pump suction. Install blowdown piping with ball valve; extend full size to nearest floor drain.

E. Install expansion tanks as indicated in piping diagrams. 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.
3. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 20 Section "Meters and Gages."

D. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:

1. Snow Melting System: Minimum 40 percent propylene glycol.

3.6 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 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 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 air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working 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 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 2 hours, 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.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Remove disposal fine-mesh strainers in pump suction diffusers.

4. Set makeup pressure-reducing valves for required system pressure.
5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
8. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232123 - 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

C. PEI: Pump Energy Index as defined by the Department of Energy.

D. PEI_{CL}: Pump Energy Index – Constant Load, as defined by the Department of Energy.

E. PEI_{VL}: Pump Energy Index – Variable Load, as defined by the Department of Energy.

1.3 ACTION SUBMITTALS

A. Product Data: 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.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all pumps and accessories to include in Operation and Maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Department of Energy Requirements: Pumps supplied that are regulated by the Department of Energy pump standards shall bear the acceptable PEI index.

1. Constant load pumps supplied shall bear the acceptable PEI_{CL} index.
2. Variable load pumps supplied with variable speed controls shall bear the acceptable $PEIv_L$ index.
3. Submittals for approval shall clearly identify the applicable PEI index and affirm that that index meets the DOE pump standards.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.8 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.

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS

A. Pump Units: Factory assembled and tested.

B. Motors: Comply with requirements in Division 20 Section “Motors”.

C. Selection:

1. Base non-overloading characteristics for pumps upon nameplate horsepower, at any point on performance curve.
2. Shaft first critical speed shall not be less than 25 percent greater than operating speed.
3. Maximum impeller diameter shall not be greater than 90 percent of “cut water” diameter for a given casing and no smaller than the smallest published diameter for casing. Do not base acceptable maximum diameter calculation on percentage of impeller diameter range for a given casing.
4. Pump speed shall be limited to 1800 RPM except as scheduled.
5. Select at the point of maximum efficiency for a given impeller-casing combination. Deviations shall be within 3 percent of maximum efficiency on the increasing capacity side of the maximum efficiency point and 7 percent on the decreasing capacity side of the maximum efficiency point.
6. Select pump at a point no greater than 85 percent of end of curve flow.
7. Maximum pump suction velocity:

    a. In-line: 12 fps.

2.2 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.

2.3 CLOSE COUPLED, IN-LINE, SEALLESS CENTRIFUGAL PUMPS WITH INTEGRAL VARIABLE FREQUENCY CONTROL

A. Manufacturers:

1. Bell and Gossett, Ecocirc XL.

2. Armstrong Pumps Inc.;
3. Grundfos Pumps Corp.
4. Taco, Inc.;

B. Description: Factory-assembled and -tested, single-stage, close-coupled, in-line, seal-less centrifugal pumps as defined in HI 5.1-5.6.

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge-type unit with motor and impeller on common shaft and designed for installation with pump and motor shaft mounted horizontally.
2. Casing: Bronze, with threaded companion-flange connections.
3. Impeller: Corrosion-resistant material.
4. Motor: Electrically commutated electrical motor (ECM) with permanent magnet rotor. Refer to Division 20 Section “Motors” for additional requirements.

C. Capacities and Characteristics: Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of 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. Support in-line centrifugal pumps greater than 1/2 HP independent of piping. Use continuous-thread hanger rods and hangers of sufficient size to support pump weight. Do not support pump from motor housing plate.

E. Refer to Division 20 Section “Mechanical Vibration Controls” for vibration isolation devices.

F. Refer to Division 20 Section “Hangers and Supports” for hanger and support materials.

G. Set base-mounted pumps on concrete bases. Disconnect flexible coupling before setting. Do not reconnect flexible couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular stainless steel blocks and shims, or on wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
3. Install pumps on inertia bases where required. Refer to Division 20 Section “Mechanical Vibration Controls” for vibration isolation devices.

H. Automatic (Cooling Coil) Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install check valve and throttling valve on discharge side of pumps. Triple-duty valves are not allowed.

E. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps as indicated on drawings.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install pressure gages on pump suction and discharge or at integral pressure-gage tappings, or install single gage with multiple-input selector valve.

H. Ground equipment according to Division 26 Section "Grounding and Bonding."

I. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service for each pump supplied. Written report of the start-up shall be provided to the Owner and Engineer upon completion of services.

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.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232300 - 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. Division 07 Section "Roof Accessories" for roof curbs, piping supports, and roof penetration boots.
2. Division 07 Section "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
3. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
4. Division 20 Section “Mechanical General Requirements.
5. Division 20 Section “Basic Mechanical Materials and Methods.”
6. Division 20 Section "Hangers and Supports" for pipe supports and installation requirements.
7. Division 20 Section "Mechanical Identification" for labeling and identifying refrigerant piping.
8. Division 20 Section "Meters and Gages" for thermometers and pressure gages.
9. Division 23 Section "Temperature Controls" for thermostats, controllers, automatic-control valves, and sensors.

1.2 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerants: 535 psig.

1.3 SYSTEMS DESCRIPTIONS

A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Filter dryers.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: 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. Show interface and spatial relationships between piping and equipment.

1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual 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.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

C. UL Standard: Provide products complying with UL 207, “Refrigerant-Containing Components and Accessories, Nonelectrical”; or UL 429, “Electrically Operated Valves.”

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.

E. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

2.2 VALVES AND SPECIALTIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Danfoss Electronics, Inc.
2. Emerson Electric Company; Alco Controls Div.
3. Henry Valve Company.
4. Parker-Hannifin; Sporlan Division.

B. 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.

C. 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 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.

D. Permanent Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig.
7. Rated Flow: 15 tons.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Arkema Inc.
2. DuPont; Fluorochemicals Div.
3. Honeywell International Inc.; Genetron Refrigerants.
4. Mexichem Fluor Inc.

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

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 adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

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

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Refer to Division 23 Section "Temperature Controls" and Sequence of Operation on the Drawings for solenoid valve controllers, control wiring, and sequence of operation.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing, 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.

P. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

Q. Seal penetrations through fire and smoke barriers according to Division 07 Section "Through-Penetration Firestop Systems."

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

T. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

U. Identify refrigerant piping and valves according to Division 20 Section "Mechanical Identification."

3.2 PIPE 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube." Brazing filler metals are specified in Division 20 Section “Basic Mechanical Materials and Methods.”

D. Purge pipe and fittings with nitrogen, during brazing to prevent scale formation.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 VALVE AND SPECIALTY INSTALLATION

A. 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.

B. 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.

C. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

D. Install flexible connectors at compressors. Flexible connectors must be installed in horizontal piping. Installation in vertical piping is prohibited.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 20 Section "Hangers and Supports."

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 sizes:

1. NPS 3/4, and soft copper tubing: Continuous support v-shaped plastic pipe channel, maximum hanger spacing 8 feet.
2. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.

4. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
8. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections 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 Part 1 "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.

3.6 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.

3.7 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 232510 - PIPING SYSTEMS FLUSHING AND CHEMICAL CLEANING

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section “Domestic Water Piping,” for disinfection of potable water piping.
4. Division 23 Section "Hydronic Piping.”
5. Division 23 water treatment sections.

1.2 SUMMARY

A. This Section includes chemical cleaning for the following piping systems:

1. Heating hot water.
2. Snowmelt heating hot water.

1.3 DEFINITIONS

A. Cleaning: Recirculating water containing chemical cleaning and passivation compounds.

B. Flushing: Using approved water on a once through basis.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Proposed cleaning chemicals and quantities.
2. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Reduced scale plans indicating locations of velocity measurements.

B. Other Informational Submittals:

1. Proposed, step-by-step, chemical cleaning procedure.
2. Circulation pump suction and discharge pressure at start and completion of chemical cleaning operations.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Service Provider Qualifications: An experienced piping systems cleaning service provider capable of applying cleaning compounds as specified in this Section.

B. Conduct safety meetings with Owner’s Representative and personnel involved in the cleaning process.

C. Assume responsibility for damage, necessary subsequent cleaning, flushing, and inspection of Work under the Contract which results from improper flushing and cleaning operations including failure to flush all dead-ends.

1.8 COORDINATION

A. Schedule flushing and chemical cleaning activities immediately after piping system pressure testing and immediately prior to piping system chemical treatment work to minimize internal oxidization or flash corrosion of piping systems.

B. Coordinate chemical cleaning work with other work to avoid accidental chemical discharge, spillage, or spray out, and electrolytically originated system damage resulting from concurrent chemical cleaning and arc welding.

C. Coordinate with work performed under other Sections to provide in-place temporary strainers, spool pieces, flushing hose connections, cross-over piping, and isolation and drain valves.

D. Boilers shall be flushed and cleaned to remove rust and oil deposits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. System Cleaning Chemicals: Subject to compliance with requirements, provide products by one of the following:

1. PVS-Nolwood Chemicals, Inc.; PVS CHILL CLP Cleaner.
2. NALCO Water, an Ecolab Company.
3. DuBois Chemicals.
4. H-O-H Chemicals, Inc.
5. SUEZ Water Technologies & Solutions
6. Enerco Corporation.

2.2 MATERIALS

A. Cleaning chemicals shall be as recommended by manufacturer and compatible with piping system components and connected equipment.

B. Cleaning and passivation chemical shall consist of an inorganic phosphate, yellow metal corrosion inhibitor (Tolytriazole), dispersant, and oil emulsifier.

C. Provide additional temporary and permanent piping, equipment, and materials required for chemical cleaning work.

D. Use potable water for flushing and cleaning operations, unless directed otherwise by the Architect.

PART 3 - EXECUTION

3.1 ACCEPTABLE SERVICE PROVIDER

A. Subject to compliance with requirements, provide chemical cleaning service by one of the following:

1. Eldon Water (Patrick Racine, Christa Blades, or Pierre Beausoleil, 888-712-4000).
2. Enerco Corporation (Doug White 517-627-8444 or 800-292-5908).
3. GE Power & Water; Water & Process Technologies.
4. Mitco Custom Water Treatment Gordon Chapin, 800-516-2175).

5. Nalco, an Ecolab Company Brian Irwin or Tony Mackovski, 248-344-7564.
6. H-O-H Chemicals, Inc. David Burton/H.V. Burton Co, 734-261-4220.

3.2 PREPARATION

A. Prior to flushing and cleaning activities, drain the system of all water used for hydrostatic testing.

B. Temporarily connect dead-end supply and return piping as necessary to result in recirculating system in which no lines are left static for purposes of flushing and cleaning. Refer to System Piping Diagrams on the Drawings for suggested locations of temporary connections for flushing and cleaning purposes.

C. Select three locations for monitoring flow rates.

3.3 INITIAL FLUSHING

A. Remove loose dirt, mill scale, metal chips, weld beads, rust and other deleterious substances without damage to system components.

B. Bypass factory cleaned equipment, unless acceptable means of protection are provided and subsequent inspection of water boxes and other "hide-out" areas takes place.

C. Isolate or protect clean system components including pumps and pressure vessels and remove components which may be damaged.

D. Open valves, drains, vents and strainers at all system levels.

E. Remove plugs, caps, spool pieces and components to facilitate early discharge from system.

F. Sectionalize system if possible to obtain debris carrying velocity of 6 FPS.

G. Connect dead-end supply and return headers as necessary or provide terminal drains in end caps.

H. Install temporary strainers where necessary to protect down-stream equipment.

I. Supply and remove flushing water and drainage by fire hoses, garden hoses, temporary and permanent piping and Contractor's booster pumps.

J. Flush for not less than one hour.

K. Inspect system including basins to determine if debris accumulation requires dewatering and cleaning prior to next phase work.

3.4 FLUSHING AND CHEMICAL CLEANING PROCEDURES

A. Remove without chemical or mechanical damage to system components adherent dirt (organic soil), oil and grease (hydrocarbons), welding and soldering flux, mill varnish, pipe compounds, rust (iron oxide), and other deleterious substances not removed by initial flushing. Removal of tightly adherent mill scale is not required.

B. Fill system with fresh water and add manufacturer's recommended volume of system cleaner to remove grease and petroleum products from piping. Circulate solution for 48 hours at a minimum velocity of 6 fps.

1. Utilize defoamers to preclude damage to existing work and adjacent electrical equipment.
2. Utilize heat to maximize effectiveness of compounds or use live steam injection where practical and safe. Do not raise cleaning water temperature in excess of controlled limits.

C. Monitor flow rates and clean strainers as required to maintain minimum specified velocity during the entire circulation and chemical cleaning period.

D. Install temporary strainer screens between pipe flange faces where necessary to protect primary system from branch connections during chemical cleaning procedures.

E. Following chemical cleaning:

1. Remove, clean, and reinstall strainer baskets.
2. Blow down and clean low points, dirt legs, and traps.

F. Drain systems:

1. Check with local authorities concerning discharge requirements and submit copies of letters or reports.
2. If acceptable, drain system to sanitary drainage system.
3. Do not under any circumstances drain to storm drainage system or open drainage ditch.
4. If discharge requirements do not allow discharge to sanitary sewer, secure the services of a licensed disposal Contractor.
5. Disposal Contractors:

a. Dynecol.
b. SQS Environmental.

G. Perform final flush to remove any remaining debris and chemical from the system:

1. Flush dead ends and isolated pre-cleaned equipment.
2. Operate valves to dislodge debris in valve body.
3. Flush for not less than 1 hour.

3.5 PLACING INTO OPERATION

A. Clean strainers.

B. Dewater and clean new sumps, basins, storage vessels and pressure vessels.

C. Disassemble, inspect, clean, repair, replace and reassemble any critical component or questionable item. Bellows style, and hose and braid flexible connectors left in place shall be removed and cleaned.

D. Preliminarily adjust control valves.

E. Install clean primary filter elements, if necessary, as determined by both pressure differential across filter and visual inspection of filter elements.

F. Close-up and fill system as soon as possible to minimize corrosion of untreated surfaces.

G. Vent air from system and adjust fill valve.

H. Immediately after completion of flushing and chemical cleaning, fill systems with potable water and make ready for chemical treatment as specified in Division 23 Section HVAC Water Treatment.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Withdraw, inspect, and test samples of water from each system after flushing and chemical cleaning is completed, to ensure system is free of contaminants.
2. If loose debris or contaminants are still present, repeat final flushing procedures until test samples and strainers remain free of debris and contaminants.

END OF SECTION 232510

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section "Mechanical General Requirements."
2. Division 20 Section "Basic Mechanical Materials and Methods."
3. Division 23 Section "Piping Systems Flushing and Chemical Cleaning."

1.2 DEFINITIONS

A. CPVC: Chlorinated Polyvinyl Chloride.

B. EPDM: Ethylene-propylene-diene monomer.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. TDS: Total dissolved solids.

E. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 PERFORMANCE REQUIREMENTS

A. Furnish the services of a firm specializing in hydronic piping system water treatment work.

1. This firm shall furnish and administer glycol for systems using glycol/water mix.

B. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

C. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

D. Base chemical quantities on estimated system size.

E. Closed hydronic systems, including hot-water heating with non-aluminum boilers, shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TDS: Maintain a maximum value of 5000 mmhos.
7. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
8. Scale Control: Provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.
9. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
    b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
    c. Ammonia: Maintain a maximum value of 20 ppm.
    d. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
    e. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
    f. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
    g. Total Hardness: Maintain a value less than ?? ppm.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Bypass feeders.

2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. TDS controllers.
6. TSS controllers.
7. Chemical solution tanks.
8. Injection pumps.
9. UV-irradiation units.
10. Chemical test equipment.
11. Chemical material safety data sheets.
12. Water softeners.
13. RO units.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

B. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. An analytical review of make-up water characteristics for each treated system operating conditions, including such items as Langlier/Ryzner Indexes. Based on this review, provide a definitive description of treatment system developed to achieve specified objectives and include generic terms to describe product formulation content and function. Detailed proprietary formulation data is not required. However, manufacturer's standard published literature is not usually acceptable.
3. A step-by-step procedure to be followed by the Contractor during flushing, purging, disinfecting, draining, disposal, pretreatment and treatment operations. The intent of the step-by-step procedure is two-fold.

    a. To assure that all essential permanent provisions to accomplish the above work are included during the course of construction.
    b. To allow the Owner to accomplish the source procedures as subsequent maintenance operations.

C. Provide OSHA equivalent materials form for hazardous substances.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports including final water quality test reports:

1. Boiler water samples taken at one-week intervals after boiler startup for a period of five weeks, and test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Boiler water taken at six -week intervals following the testing

noted above to show that heating systems are maintaining water quality within performance requirements specified in this Section.

2. Samples taken at six -week intervals following Substantial Completion, on hydronic systems to show that systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Conform to applicable codes for addition of non-potable chemicals to building mechanical systems, and for delivery to public sewage systems.

1.8 OWNER'S INSTRUCTIONS

A. Provide a coordinated water treatment training program oriented to the needs common to operating personnel and maintenance personnel and to the needs of maintenance personnel only, sufficiently prior to acceptance of the work, upon mutually satisfactory arrangement with the Architect.

B. Provide a total of not less than eight "field" hours encompassing mechanical, electrical, chemical, pollution and safety aspects, sufficient for personnel to operate and maintain systems and consistently achieve specified objectives, with subsequently scheduled guidance by the water treatment laboratory.

C. Water treatment laboratory chemical engineer, complemented by instrument engineer, supplemented by Contractor's staff, shall comprise the training staff.

D. Training materials shall include "survey," limits control program, shop drawings, operating and maintenance manuals, safe handling of chemicals, chemical testing, use of log sheets and demonstrations of installed and functioning systems.

E. On completion of the installation of the entire purified water system, conduct a thorough check and test of all components in the system. During this period, instruct the Owner's personnel in the theory, operation, and maintenance of the system. When this work is finished, start up the system and operate it for as long as necessary to complete two consecutive days of operation at the specified performance levels. During this period, continue to instruct the Owner's personnel.

1.9 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for heating, hot-water piping and

equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Provide piping/plumbing recommendation to optimize chemical program results.
2. Initial water analysis and HVAC water-treatment recommendations.
3. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
4. Quarterly field service and consultation.
5. Customer report charts and log sheets.
6. Laboratory technical analysis.
7. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

B. Glycol manufacturer shall provide testing services every six months of samples submitted by the Owner. Fluid shall be tested at no charge for: glycol percent, pH, reserve alkalinity, dissolved metals, magnesium, calcium, chlorides, acidity, and inhibitor components. Testing service shall be for the life of the fluid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers/Suppliers: Unless otherwise specified, and subject to compliance with requirements, provide products by one of the following:

1. Ashland Specialty Chemical Company; Drew Industrial Div.
2. Eldon Water Inc.; a brand within the Water Treatment Solutions division of DuBois Chemicals, Inc.
3. Enerco Corporation.
4. SUEZ Water Technologies & Solutions
5. DuBois Chemicals.
6. NALCO Water, an Ecolab Company.
7. H-O-H Chemicals, Inc.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 2 gal.
2. Minimum Working Pressure: 125 psig.

2.3 CHEMICAL TREATMENT TEST EQUIPMENT

A. Corrosion Test-Coupon Assembly (Corrosion Racks): Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Two-station rack for closed-loop systems.
2. Include 1-inch diameter, chemical resistant acrylic flowmeter suitable for 1 to 20 gpm at exit of coupon rack.

2.4 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

B. Inhibited Ethylene Glycol: Industrially inhibited ethylene glycol, easily analyzed for glycol concentration and inhibitor level, and easily re-inhibited using replacement inhibitor readily available from fluid manufacturer. Premix inhibited glycol solution and deionized water to specified concentration. Automotive anti-freeze is unacceptable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Chemical; Dowtherm SR-1.
b. Eldon Water Inc.; a brand within the Water Treatment Solutions division of DuBois Chemicals, Inc.
c. Houghton Chemical Corporation.
d. Interstate Chemical Company; Intercool OP100.
e. NALCO Water, an Ecolab Company.
f. PVS-Nolwood Chemicals, Inc.; Chill EGHD.

C. Inhibited Propylene Glycol: Single nationally marketed brand of propylene glycol, inhibited for industrial applications, and readily available in bulk quantities from a firm offering free testing and advisory service to bulk users as to inhibitor replenishment needs. Premix inhibited glycol solution and deionized water to specified concentration. Automotive anti-freeze is unacceptable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Chemical; Dowfrost HD.
b. Eldon Water Inc.; a brand within the Water Treatment Solutions division of DuBois Chemicals, Inc.
c. Houghton Chemical Corporation.
d. Interstate Chemical Company; Intercool P300.
e. NALCO Water, an Ecolab Company.
f. PVS-Nolwood Chemicals, Inc.; Chill PGHD.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Install meters and equipment requiring service at a maximum 60 inches above finished floor.

D. Install interconnecting control wiring for chemical treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equipped with the following:

1. Install bypass feeder in a bypass circuit on main header having pressure differential greater than or equal to 20 psig, unless otherwise indicated on Drawings.
2. Install water meter in makeup water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

G. Install glycol feed system in accordance with manufacturer’s instructions.

3.3 CHEMICAL INSTALLATION

A. Utilize softened or reverse osmosis water for initial system fill

B. Add specified chemicals to meet performance requirement specified in Part 1 of this Section.

C. Clean and flush glycol system before adding premixed glycol solution.

D. Fill systems indicated to have antifreeze or glycol solutions with the following premixed concentrations. Batch feeding of glycol is prohibited.

1. Snow Melting System: Minimum 50 percent propylene glycol.

E. Perform tests determining strength of glycol and water solution and submit written test results.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 20 Section "Basic Mechanical Materials and Methods."

D. Install make-up water meters where indicated on the drawings.

E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 20 Section "Valves."

F. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

G. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.

H. Ground equipment according to Division 26 Section "Grounding and Bonding."

I. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. 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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Remove and replace malfunctioning units and retest as specified above.

E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at six -week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

F. At six-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

G. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Steam System: ASTM D 1066.
3. Acidity and Alkalinity: ASTM D 1067.
4. Iron: ASTM D 1068.
5. Water Hardness: ASTM D 1126.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232513

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section "Mechanical General Requirements."
2. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, relief air, and exhaust air-distribution systems.

1.3 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: Up to and including 2 inch WG and velocities less than 1,500 fpm.

C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 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 Application Schedule" Article.

1.6 ACTION SUBMITTALS

A. Shop Drawings: Drawn to scale. Show fabrication and installation details for metal ducts. Shop drawings shall be reviewed and approved by the Architect prior to any fabrication.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.8 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

1.9 QUALITY ASSURANCE

A. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

1.10 COORDINATION

A. Sheet metal trades shall cooperate fully with the Test and Balance Contractor and provide all miscellaneous caps and any other materials required for structural integrity and leakage testing of the complete duct system in whole or in part. Refer to Division 23 Section "Testing, Adjusting and Balancing."

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

B. Sheet metal trades shall participate in the above ceiling coordination program. Refer to Division 01 requirements.

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 SHEET METAL 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: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation.

C. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

D. Stainless Steel: ASTM A 480/A 480M, Type 316, and having a No. 2D finish for concealed ducts and No. 4 for exposed ducts.

E. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

F. Reinforcement Shapes and Plates:

1. Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
2. Compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods:

1. Galvanized Steel Duct: Galvanized steel, 3/8-inch minimum diameter.
2. Ducts in Humid or Corrosive Atmospheres: Stainless steel, 1/4-inch diameter for lengths 36 inches or less; 3/8-inch diameter for lengths longer than 36 inches .

2.3 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Manufacturers:

a. CertainTeed Corp.; Insulation Group.
b. Johns Manville International, Inc.
c. Knauf Fiber Glass GmbH.

2. Materials: ASTM C 1071, Type I, flexible; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

a. Thickness: 1 inch.
b. Density: 1-1/2 pounds per cubic foot.
c. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
e. Maximum Operating Temperature: 250 deg F when tested according to ASTM C 411.
f. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
g. 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 duct.

1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

3. Noise reduction coefficient (NRC): Sound absorption coefficients shall not be less than those in the table below as tested by ASTM C423 using an ASTM E795 Type A mounting.

	Sound absorption coefficients at octave band center frequencies, Hz						
Thickness Inches	125	250	500	1000	2000	4000	NRC
1	.08	.31	.59	.84	.91	.90	.70

2.4 SEALANTS 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. Elastomeric Sealant Tape: 3 inches wide; modified butyl adhesive backed.

1. Manufacturers:

a. Hardcast; Foil-Grip 1402 and Foil-Grip 1402-181BFX.

C. Water-Based Joint and Seam Sealant:

1. Manufacturers:

a. Design Polymerics; DP1010 Water Based Duct Sealant.
b. Hardcast; Flex-Grip 550 and Versa-Grip 181.
c. Polymer Adhesives; No. 11.
d. United McGill.

2. Application Method: Brush on.
3. Solids Content: Minimum 63 percent.
4. Shore A Hardness: Minimum 20.
5. Water resistant.
6. Mold and mildew resistant.
7. VOC: Maximum 75 g/L (less water).

8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Manufacturers:

a. Hardcast; Sure-Grip 404.
b. United McGill.

2. Application Method: Brush on.
3. Base: Synthetic rubber resin.
4. Solvent: Toluene and heptane.
5. Solids Content: Minimum 60 percent.
6. Shore A Hardness: Minimum 60.
7. Water resistant.
8. Mold and mildew resistant.
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel, 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.

F. Gaskets: Chloroprene elastomer, 40 durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-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.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

E. Load Rated Cable Suspension System for Noncorrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.

1. Cable: Aircraft quality 7 x 7 and 7 x 19 wire rope.

    a. Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
    b. Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
4. Manufacturers:

    a. B-Line by Eaton; KwikWire.
    b. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
    c. Duro Dyne Corp.; Dyna-Tite System.
    d. Gripple Inc.; Hang-Fast System.

F. Stainless Steel Load Rated Cable Suspension System for Corrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.

1. Cable: Aircraft quality stainless steel 7 x 7 and 7 x 19 wire rope.

    a. Stainless steel complying with ASTM A 492.

2. Fastener: One-piece, stainless steel housing with Type 302 S26 stainless steel hardened and tempered springs, and ceramic locking wedges.
3. End Fixings:

    a. Loop End: Type 316L/A4 stainless steel.
    b. Stud or Toggle End: Type 304L/A2 stainless steel.
    c. Plain end suitable for stainless steel wire rope beam clamp.

4. Manufacturers:

    a. B-Line by Eaton; KwikWire.
    b. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
    c. Duro Dyne Corp.; Dyna-Tite System.
    d. Gripple Inc.; Hang-Fast System.

G. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel structural support systems may be used in lieu of mill rolled structural steel.

2.6 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
3. Internal Tie Rods: As allowed by SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's and SMACNA guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:

    a. Ductmate Industries, Inc.
    b. Nexus Inc.
    c. Ward Industries, Inc.

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.7 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. 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.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. 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.

G. 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:

1. Fan discharges.
2. Intervals of lined duct preceding unlined duct.
3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.

2.8 ROUND DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA “Industrial Duct Construction Standards” as required based on pressure class.

1. Round fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

C. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Bolts and fasteners for galvanized steel duct shall be carbon steel, zinc coated per ASTM A153. Bolts and fasteners for stainless steel and polyvinyl chloride coated steel duct shall be stainless steel.
4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

D. Low Pressure Ductwork (plus or minus 2 inches W.G. Static Pressure Class)

1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

E. Medium and High Pressure Ductwork (For Static Pressure Class Greater than plus or minus 2 inches W.G.)

1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
2. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.

3. Fabricate continuously welded medium and high pressure round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
4. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

F. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

G. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

H. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
3. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
4. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
5. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
6. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
7. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, and sleeves. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."

1. Where ducts not having fire dampers, smoke dampers, or combination fire and smoke dampers pass through fire-rated partitions, maintain indicated fire rating. Seal penetrations with firestop materials. Refer to Division 07 Specification Sections for materials and UL classified firestop systems.

O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

P. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

1. Intermediate level.

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 RANGE HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS

A. Install ducts to allow for thermal expansion through 2000 deg F temperature range.

B. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.

C. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1-1/2 inches from bottom; and fit with grease-tight covers of same material as duct.

D. Install welded test ports or prefabricated test port section in the exhaust duct for the duct Pitot-tube traverse. Install each test port with a threaded cap that is liquid tight.

E. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.

F. Field Quality Control:

1. Prior to use or concealment of any portion of grease duct system, perform leakage test in presence of Code Official.
2. Light test or approved equivalent test method shall be performed to determine that welded and brazed joints are liquid tight.
3. Lamp shall be not less than 100 watts and shall be open to emit light equally in all directions perpendicular to duct walls.

3.4 DUCT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. Ducts must be properly cleaned and sealed in strict accordance with sealant manufacturer’s instructions.

1. Seal Class: Refer to Application Schedule on the Drawings.
2. Seal ducts before external insulation is applied.
3. After pressure testing, remake leaking joints until leakage is equal to or less than maximum allowable. Refer to Application Schedule on the Drawings for allowable leakage rates.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. 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.

C. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

D. Support ductwork from building structure, not from roof deck, floor slab, pipe, other ducts, or equipment.

E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

F. Install roof mounted duct supports in accordance with manufacturer’s instructions. Provide additional membrane layer or walkpads under support bases as required.

G. Use load rated cable suspension system for round duct in exposed locations.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. 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 Division 09 painting Sections.

3.8 FIELD QUALITY CONTROL

A. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

B. Duct system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233113

SECTION 233300 - 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 23 Section “Testing, Adjusting, and Balancing” for duct test holes.
3. Division 23 Section “Temperature Controls” for motorized control dampers.
4. Division 28 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.2 DEFINITIONS

A. NVLAP: National Voluntary Laboratory Accreditation Program.

B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.

C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For turning vanes, include data for pressure loss generated sound power levels.

1.4 INFORMATIONAL SUBMITTALS

A. 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.
e. Duct security bars.
f. Wiring Diagrams: Power, signal, and control wiring.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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 SHEET METAL 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.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation.

C. Stainless Steel: ASTM A 480/A 480M, Types 304 and 316 as indicated.

D. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.

E. Bird Screens: No. 2 mesh, 0.063 inch diameter galvanized wire screen with open area of not less than 72 percent. Conceal sharp edges by adding metal edging consisting of rod, flat or angle iron, or 16 gage galvanized sheet steel turned over at least 3/4 inch on both sides.

2.3 LOW PRESSURE MANUAL VOLUME DAMPERS

A. Manufacturers:

1. American Warming and Ventilating; Mestek, Inc.
2. Arrow United Industries; Mestek, Inc.
3. Greenheck Fan Corporation.
4. Krueger-HVAC; Air Distribution Technologies, Inc.; a JCI Company.
5. Louvers and Dampers, Inc.; Mestek, Inc.
6. Nailor Industries Inc.
7. Ruskin Company.
8. Vent Products Co., Inc.
9. Young Regulator Co.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Except for dampers in round ductwork sized 12 inches and smaller, provide end bearings.

C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

F. Damper Materials:

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Blade Axles: Galvanized steel.
4. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
5. Tie Bars and Brackets: Galvanized steel.

G. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

H. Damper Hardware: 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. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

I. Positive-Locking Damper Hardware:

1. Manufacturers:

a. Duro Dyne Corporation; Dyna-Click.
b. Rossi Hardware; Everlock.
c. Windgate Products Co., Inc.; Sure-Loc & Sure-Loc HD.

2. Quadrant Material: 18 gage galvanized steel stainless steel with 11 to 15 locking positions.
3. Handle material: Die-cast aluminum or flame-retardant high-strength polymer.
4. Include center hole to suit damper operating-rod size.
5. Include elevated platform for insulated duct mounting on either round or rectangular duct.

2.4 MOTORIZED CONTROL DAMPERS

A. Refer to Division 23 Section “Temperature Controls.”

2.5 FIRE DAMPERS (CURTAIN STYLE)

A. Manufacturers:

1. Air Balance, Inc.; Mestek, Inc

2. Greenheck Fan Corporation.
3. NCA; a brand of Metal Industries Inc.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Dynamic fire dampers with curtain style blades, and labeled according to UL 555, maximum velocity 2000 fpm, maximum static pressure 4 inches w.g.

C. Fire Rating:

1. 1-1/2 hours for 2 hour rated walls.
2. 3 hours for 4 hour rated walls.

D. Frame: Type B or Type C Curtain type with blades outside airstream; fabricated with roll-formed, galvanized steel in gages required by manufacturer's UL listing; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. 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.

H. Fusible Links: Replaceable, 212 deg F rated.

2.6 SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.; Mestek, Inc
2. Greenheck Fan Corporation.
3. NCA; a brand of Metal Industries Inc.
4. Nailor Industries Inc.
5. Ruskin Company.

B. General Description: Smoke dampers with airfoil blades, labeled according to UL 555S, with minimum Class II leakage rating.

C. Frame and Blades: 16 gage, galvanized sheet steel.

D. Mounting Sleeve: Factory-installed, galvanized sheet steel.

1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.

E. Rated pressure and velocity to exceed design airflow conditions.

F. Damper Actuators: Electric modulating or two-position action as required.

1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
2. Size for torque required for damper seal at load conditions.
3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
4. 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.
5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac (coordinate with Controls contractor).
6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.
7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.
8. Actuator timing shall meet 15 sec.
9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.

G. Damper blade position end switches: Factory installed damper position switch package for both full open and full closed indication (equivalent to Ruskin SP100 switch package).

H. Test Switch: Damper mounted momentary “test” push- switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.

1. Include damper mounted “open” and “closed” indication lights on switch plate for connection to factory installed damper blade position end switches.

2.7 TURNING VANES

A. Manufactured Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane or airfoil-shaped, curved blades of galvanized sheet steel set into vane runners suitable for duct mounting.
3. Generated sound power level shall not exceed 54 decibels in octave band 4 at 2000 fpm in a 24-inch by 24-inch duct.
4. Manufacturers:

a. Aero-Dyne Sound Control; H-E-P Turning Vanes & Rail.
b. Ductmate Industries, Inc.
c. Duro Dyne Corporation.
d. Ward Industries, Inc.; a JCI Company.

B. Manufactured Acoustic Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane curved blades of galvanized sheet steel with perforated faces and fibrous-glass fill set into vane runners suitable for duct mounting.
3. Manufacturers:

    a. Ductmate Industries, Inc.
    b. Ward Industries, Inc.; a JCI Company.

2.8 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class. Doors may be field fabricated in accordance with SMACNA Standards, or commercially produced.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:

    a. Air Balance, Inc.; Mestek, Inc.
    b. Greenheck Gan Corporation.
    c. Nailor Industries Inc.
    d. Ruskin Company.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:

    a. Less Than 12 Inches Square: Secure with two sash locks.
    b. Up to 18 Inches Square: Two hinges and two compression locks.
    c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
    d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Manufacturers:

    a. Ductmate Industries, Inc.
    b. Flexmaster U.S.A.; a Masterduct Company.

2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.9 GREASE DUCT ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Flame Gard Inc.
3. 3M.

B. Description: Factory-fabricated, -listed, and -labeled, double-wall personnel and maintenance access doors tested according to UL 1978 and rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

1. Construction: 0.0625 inch ASTM A 666, Type 304 stainless-steel inner shell; and aluminized-steel indoor or stainless-steel outdoor outer cover with two handles.
2. Fasteners: Stainless-steel bolts and wing nuts.

    a. Ensure that bolts do not penetrate interior of duct space.

3. Maintenance Access Door Dimensions: Minimum 7 x 7 inches.
4. Personnel Access Door Dimensions: Minimum 24 x 24 inches.
5. Door Label: Mark door with uppercase lettering as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

C. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

D. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers:

1. ADSCO Manufacturing LLC.
2. Duro Dyne Corp.
3. Senior Flexonics Pathway.
4. Ventfabrics, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. 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 20 to plus 200 deg F.

2.11 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE

A. Manufacturers:

1. Flexmaster U.S.A.; a Masterduct Company; Type 1M Acoustical.
2. Hart & Cooley.
3. Thermaflex; part of the Flexible Technologies Group.

B. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction or fabric supported by helically wound spring steel wire or flat steel bands; rated to 6 inches WG positive and 4 inches WG negative for low and medium pressure ducts.

C. Insulated Flexible Ducts: UL 181, Class 1, flexible duct wrapped with flexible glass fiber insulation, enclosed by a fire retardant polyethylene vapor barrier jacket; maximum 0.23 K value at 75 deg F.

D. Acoustical performance tested in accordance with the Air Diffusion Council's *Flexible Air Duct Test Code FD 72-R1, Section 3.0, Sound Properties* shall be as follows:

The insertion loss (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	8	32	38	35	39	25
8" diameter	13	32	36	35	36	21
12" diameter	15	29	28	33	26	14

The radiated noise reduction (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	6	8	7	8	9	13
8" diameter	9	6	6	7	8	10
12" diameter	9	7	6	6	8	11

The self-generated sound power levels (LW) dB are 10-12 Watt of a 10 foot length of straight duct for an empty sheet metal duct when tested in accordance with ASTM E477, at a velocity of 1000 feet per minute, shall not exceed:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	42	31	23	18	17	21
8" diameter	41	34	27	19	18	21
12" diameter	53	44	36	27	21	22

E. Flexible Duct Fittings: Galvanized steel, twist-in design with damper. Size as indicated.

F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.12 FLEXIBLE DUCT ELBOW SUPPORTS

A. Manufacturer:

1. Titus; Air Distribution Technologies, Inc.; a JCI Company; FlexRight.
2. Thermaflex; part of the Flexible Technologies Group; FlexFlow Elbow.
3. Hart and Cooley, Inc.; Smart Flow Elbow.

B. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6 inches through 16 inches.

C. Elbow supports shall be UL listed for use in return air plenum spaces.

2.13 DUCT ACCESSORY HARDWARE

A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND 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. Provide 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 PVC coated ducts; and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. 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 stainless steel volume dampers in stainless steel ducts.
3. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install fire dampers and smoke dampers according to UL listing.

G. Install access doors with swing against duct static pressure.

H. Install duct-mounting, rectangular access doors with long dimension at right angles to direction of airflow and of largest standard size which can be accommodated in duct. Maximum size: 21 by 14 inches.

I. Install pressure relief doors vertically and level in accordance with manufacturer's instructions, between the fan and first operable damper.

J. Label access doors according to Division 20 Section "Mechanical Identification."

K. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

L. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect diffusers to low pressure ducts flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with plenum-rated draw bands.

P. Install flexible duct elbow supports at each diffuser, grille, or register, and elsewhere as indicated.

Q. Install turning vanes in rectangular duct elbows in excess of 45 degrees, and where indicated:

1. Use manufactured double-vane turning vanes unless otherwise specified.
2. Seat outboard-most vane in heal of duct elbow.
3. Provide vanes for all runner punchings. Practice of eliminating every other vane is prohibited.
4. Use single-vane turning vanes in low pressure square elbows.

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.

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire dampers, combination fire and smoke dampers, and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233300

SECTION 233423 - 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Motors.”
3. Division 20 Section “Variable Frequency Controllers.”
4. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving equipment.

1.2 PERFORMANCE REQUIREMENTS

A. Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and 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.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For power ventilators to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section "Roof Accessories."

1.9 EXTRA MATERIALS

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. Belts: One set for each belt-drive unit.

PART 2 - PRODUCTS

2.1 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing; Acme Fan Group.
2. Aerovent; a Twin City Fan Company.
3. Greenheck Fan Corporation.
4. Loren Cook Company.
5. Moffitt Corporation.
6. Peerless Blowers.
7. PennBarry; Division of Air System Components.

B. Description: Direct-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

C. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

D. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

E. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

F. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Sheaves: Cast iron with split, tapered bushing; dynamically balanced at factory.

4. Motor Sheaves: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select sheave so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
6. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
7. Refer to Division 23 Section “Common Work results for HVAC” for additional requirements.

G. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Wall Sleeve: Galvanized steel to match fan and accessory size.
3. Weathershield Hood: Galvanized steel to match fan and accessory size.
4. Weathershield Front Guard: Galvanized steel with expanded metal screen.
5. Variable Frequency Controller: Refer to Division 20 Section “Variable Frequency Controllers.”
6. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

H. Capacities and Characteristics: Refer to schedule(s) on Drawings.

I. Vibration Isolators: Refer to Division 20 Section “Mechanical Vibration Controls.”

J. Spark Arrestance Class: B.

2.2 MOTORS

A. Comply with requirements in Division 20 Section "Motors."

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with 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. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 20 Section "Mechanical Vibration Controls."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 20 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor sheaves as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

SECTION 233439 - HIGH-VOLUME, LOW-SPEED DESTRATIFICATION FANS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Motors.”

1.2 DEFINITIONS

A. HVLS: High-volume, low-speed.

B. Free Air: Air within a given space at a constant static pressure.

C. LEC: Light-emitting diode.

D. VFC: Variable frequency controller. Variable frequency controllers may also be referred to as variable speed drives, variable frequency drives, VSDs, or VFDs in other Specification Sections or on the Drawings.

1.3 PERFORMANCE REQUIREMENTS

A. Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance data 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.
5. Fan speed controllers.

1.5 INFORMATIONAL SUBMITTALS

A. 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.

1. Wiring Diagrams: Power, signal, and control wiring.

B. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. 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.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For HVLS destratification fans to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.1 MEDIUM TO LARGE SPACE HVLS FANS (COMMERCIAL GRADE)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Delta T Corp.; dba the Big Ass Fan Company; Element, Essence and Isis Fans
2. Entrematic Group AB; Entrematic C-Class.
3. Greenheck Fan Corporation; DC-5 and DS-3.
4. Macro Air Technologies LLC.

B. Airfoils:

1. Material: Precision extruded 6063 aluminum alloy, weighing no more than 5.1 pounds per foot of length. Airfoils shall be heat treated for strength.
2. Fan shall have 3 or more low speed airfoils, depending on fan size.
3. Each airfoil shall incorporate a wickerbill or Gurney flap molded along the trailing edge of the airfoil. Airfoils may also incorporate winglets, and air fences.
4. The foils shall be connected to the hub section of the fan by means of 2 locking bolts per foil, providing no less than 7257 lbs. of shear strength.
5. Airfoils shall be interlocked with a safety strap constructed of 14 gage galvanized A36 steel to prevent individual airfoils from becoming accidentally disconnected from the hub.

C. Motors: Permanent magnet type. Comply with requirements in Division 20 Section “Motors.”

D. Drive Train: Gearless direct drive.

E. Fan Motor Frame and Mount: Constructed of 1/4-inch powder-coated steel. The mount shall be designed so that both guy wires and safety cables can be securely attached.

F. Hub Assembly: Precision cast of prime 713 aluminum alloy or equivalent. The hub shall incorporate four safety clips made of 1/4-inch steel to provide a physical brake for the motor in case of shaft failure.

G. Fan Mount: Designed for secure mounting of the fan from a structure's support beams. Mounting system shall allow easy removal and relocation, if required. Fan mount shall be lightweight and constructed of 1/4-inch powder coated steel.

H. Guy Wires: Four sets of self-locking wire rope and grip locks of sufficient length shall be provided to guy the fan to the building structure. Guy wires shall be of stranded galvanized steel of 0.20-inch diameter with a minimum breaking load of not less than 1000 pounds.

I. Safety Cables: Safety cable shall consist of a 7 x 19 class stranded galvanized steel of 0.20-inch diameter with 4 clamps to secure the motor frame to the structural member from which the fan is attached. The safety cable shall have a breaking strength of not less than 14,200 pounds.

J. Fan Controller: UL listed as Enclosed Industrial Control Panels and built in accordance with construction guidelines set forth by Underwriters Laboratories Article 508A, and the National Electrical Code.

1. Each fan controller shall include a factory programmed VFC to provide a soft-start for the fan as well as infinite speed control capability for the fan(s). The VFC will be sized based on the motor's maximum current requirements under locked rotor torque demands. When more than one fan motor is controlled by a VFC, the size of the VFC will be based on the maximum current requirements of the total peak currents of all motor loads under the worst operating conditions. Multiple motor systems will also include a solid state overload relay for each motor.
2. Each fan controller built for 480 volt power shall be equipped with a properly rated load reactor for handling voltage irregularities. Load reactors shall be minimum 3 percent impedance per unit and shall be provided integral to the VFC as a part of the fan controller package.
3. Equip each fan controller with an ON/OFF switch, speed control potentiometer, safety disconnect, and properly sized fuse block. Controls shall be housed in NEMA 250, Type 1 enclosure to prevent accidental contact with the enclosed equipment, and to preclude entry of unwanted substances.

K. Fan Controller Program: Controller shall be factory programmed to minimize fan starting torque to approximately 15 ft-lbs. to extend operating life by minimizing stress on components. Additionally, controller shall allow fan speed to be easily altered to optimize fan use in any conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install destratification fans level and plumb.

B. Support suspended units from structure.

C. Install units with clearances for service and maintenance.

D. Fans with bamboo airfoils shall not be installed outdoors or in damp environments.

E. Label units according to requirements specified in Division 20 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices, and connections to 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. Verify lubrication for bearings and other moving parts.
5. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

B. Lubricate bearings.

END OF SECTION 233443

SECTION 233500 - SPECIAL EXHAUST SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Motors.”
3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving equipment.

1.2 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

B. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. 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.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 TAILPIPE EXHAUST SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Plymovent.

B. Flexible Exhaust Tubing: Diameter and length indicated on Drawings.

1. Abrasion resistant, 2-ply, fire retardant fabric, heat resistant cloth base, capable of withstanding 650 deg F.
2. Tubing shall have bonded exterior scuff strip to provide abrasion resistance, and exterior steel-spring wire reinforcing spiral encased within fabric laminations to prevent collapsing.
3. Terminate tubing with tailpipe clamp/quick release adaptor.

C. Tubing Storage Reel: Frame and drum of welded steel construction.

1. Flange mounted flexible tubing assembly bolted to air entry fitting on drum.
2. Drum supported at one end by 1 inch internally gusseted steel shaft through a heavy duty cast steel flange bearing.
3. Storage reel of sufficient size to fully accommodate 25 feet of tubing.
4. Storage reel fitted with enclosed spring mechanism providing automatic rewind when flexible tubing assemble is not in use.

a. Provide with 3 ratchet stops to allow partial or complete extension of tubing, and allowing adapter positioning in increments not greater than 18 inches.
b. Short pull on adaptor shall release holding device and allow tubing assembly to automatically rewind onto drum.
c. Reel equipped with spring loaded mechanical stop mechanism to limit number of drum rotations to prevent overextension of tubing and to automatically stop rewind function when tubing is fully rewound on drum.

D. Exhaust Fan: Direct drive, single inlet, single width, backward inclined, non-overloading centrifugal fan with single thickness blades and cast iron hub.

1. Fan statically and dynamically balanced with machined keyway to match motor shaft.
2. Housing: Constructed of heavy gage cold rolled steel, welded construction, with inlet cone and Heresite coating.
3. Fan Motor: Industrial grade, C-face type bolted directly to housing.
4. Average reading over 3 mils deflection will not be accepted.

5. Capacities and Characteristics: Refer to Schedule on Drawings.

2.2 MOTORS

A. Comply with requirements in Division 20 Section "Motors."

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with 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. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install packaged exhausters and collectors level and plumb.

B. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 20 Section "Mechanical Vibration Controls."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 20 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to packaged exhausters to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

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. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

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.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain special exhaust systems and equipment.

END OF SECTION 233500

SECTION 233600 - 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 23 Section “Metal Ducts.”
3. Division 23 Section “Temperature Controls.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Liners and adhesives.
2. Sealants and gaskets.

1.3 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
2. Wiring Diagrams: Power, signal, and control wiring.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in operation and maintenance manuals. Include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.6 COORDINATION

A. Coordinate layout and installation of air terminal units 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.

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 SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers:

1. Krueger-HVAC; Air Distribution Technologies, Inc.; a JCI Company.
2. Nailor Industries, Inc.
3. Price Industries.
4. Titus; Air Distribution Technologies, Inc.; a JCI Company.
5. Tuttle & Bailey; Air Distribution Technologies, Inc.; a JCI Company.

B. Configuration: Variable and constant volume, medium pressure terminal units with casing, 100 percent tight shutoff volume regulator, velocity sensor, and sound attenuating thermal insulation.

C. Casing: Constructed of 0.034-inch mill galvanized steel or 0.032-inch aluminum.

1. Casing Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Velocity Sensor: Multipoint averaging array. Sensor located in air inlet.

F. Attenuator Section: 0.034-inch mill galvanized steel or 0.032-inch aluminum sheet metal.

1. Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.

G. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.

A. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section "Temperature Controls."

2.3 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.

2.4 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

B. Verification of Performance: Rate air terminal units according to AHRI 880.

C. Acoustical Applications and Sound Evaluation: Based on AHRI Standard 885-98, “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.”

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 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached. Refer to Division 20 Section “Hangers and Supports” for additional information.

1. Where practical, install concrete inserts before placing concrete.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. 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 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot Water Piping: Unless otherwise indicated:

1. Install union and isolation valve on supply-water connection.
2. Install union and calibrated balancing valve or PICCV as indicated on the Drawings on return-water connection.
3. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

D. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

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.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
2. Verify that controls and control enclosure are accessible.
3. Verify that control connections are complete.
4. Verify that nameplate and identification tag are visible.
5. Verify that controls respond to inputs as specified.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713 - 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.

B. Related Sections include the following:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 20 Section “Mechanical General Requirements.”
3. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each 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.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

PART 2 - PRODUCTS

2.1 AIR DIFFUSION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Krueger-HVAC; Air Distribution Technologies, Inc.; a JCI Company.
2. Nailor Industries, Inc.
3. Price Industries.
4. Titus; Air Distribution Technologies, Inc.; a JCI Company.
5. Tuttle & Bailey; Air Distribution Technologies, Inc.; a JCI Company.

B. Terminal air diffusion devices have been chosen in terms of specific air distribution requirements, spacing, and sound characteristics.

C. Provide plaster frames for units installed in plaster ceilings.

D. Provide gaskets for supply terminal air devices mounted in finished surfaces.

E. Finish:

1. Device Face and Visible Trim: Standard off white baked enamel finish unless noted otherwise.
2. Device Interior Surfaces, Including Blank-Offs and Boots: Black matte finish.

F. Air pattern adjustments shall be made from the face of the device.

G. Refer to drawings and schedules for quantities, types, and finishes.

H. Coordinate frame types with Architectural Reflected Ceiling Plan.

2.2 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."

B. Acoustical Applications and Sound Evaluation: Based on ARI Standard 885-98, “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.”

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 practicable. 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. Wall-Mounted Supply Registers: Install 6 inches below finished ceiling unless otherwise indicated.

D. 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 233713

SECTION 233723 - AIR INTAKE AND RELIEF HOODS

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. Division 08 Section "Louvers and Vents" for ventilator assemblies provided as part of the general construction.
2. Division 20 Section “Mechanical General Requirements.”
3. Division 23 Section "Power Ventilators" for roof-mounting exhaust fans.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Intake and relief ventilators shall be capable of withstanding the effects of gravity loads, wind loads, and thermal movements without permanent deformation of components, noise or metal fatigue, or permanent damage to fasteners and anchors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated]

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: For intake and relief ventilators. Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure.

B. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which roof curbs and ventilators will be attached.
2. Sizes and locations of roof openings.

C. Samples for Verification: For each type of exposed finish required for intake and relief ventilators.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain ventilators through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of intake and relief ventilators and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.6 COORDINATION

A. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use Phillips flat, hex-head or Phillips pan-head screws for exposed fasteners, unless otherwise indicated.

E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION, GENERAL

A. Factory or shop fabricate intake and relief ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.4 GRAVITY INTAKE AND RELIEF HOODS (RECTANGULAR)

A. Manufacturers:

1. Acme Engineering & Manufacturing.
2. Greenheck Fan Corporation; Fabra-Hood.
3. Loren Cook Company.
4. Moffitt Corporation.
5. PennBarry; Division of Air System Components.

B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.

C. Materials: Aluminum sheet, minimum 0.063-inch- thick base and 0.050-inch- thick hood; suitably reinforced.

D. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.

2.5 ACCESSORIES

A. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inchchemically treated wood nailer. Size as required to suit roof opening and hood base.

1. Manufacturers: Roof curbs shall be provided by the hood manufacturer, or one of the following:

a. Creative Metals.
b. Pate.
c. Roof Products & Systems.
d. ThyCurb.
e. Any of the listed hood manufacturers.

2. Configuration: Self-flashing without a cant strip, with mounting flange, and suitable for flat roofs with tapered insulation.
3. Height: Curb shall extend a minimum 18 inches above top surface of roof insulation.

B. 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 chemically treated wood nailer. Size as required to suit roof opening and hood base.

1. Manufacturers: Roof curbs shall be provided by the hood manufacturer, or one of the following:

a. Creative Metals.
b. The Pate Company.
c. Roof Products & Systems.
d. Thybar Corporation.
e. Any of the listed hood manufacturers.

2. Configuration: Built-in raised cant with step dimension matching insulation thickness, with mounting flange, and suitable for sloped roofs with uniform insulation thickness.
3. Height: Curb shall extend a minimum 18 inches above top surface of roof insulation.
4. Pitch Mounting: Manufacture curb for roof slope, top of curb shall be level.

C. Motorized Backdraft Damper: Refer to DAMPERS – AUTOMATED in Division 23 Section “Temperature Controls.”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install intake and relief hoods level, plumb, and at indicated alignment with adjacent work.

B. Secure intake and relief hoods to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible.

C. Install intake and relief hoods with clearances for service and maintenance.

D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.

F. Label intake and relief hoods according to requirements specified in Division 20 Section "Mechanical Identification."

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723

SECTION 233813 - COMMERCIAL KITCHEN HOODS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 23 Section "Power Ventilators" for exhaust fans.
3. Division 23 Section "Temperature Controls" for automatic controls for exhaust fans, makeup air units, and fire alarm systems.

1.2 DEFINITIONS

A. Listed Hood: A hood tested according to UL 710 by an NRTL acceptable to authorities having jurisdiction.

B. Standard Hood: A hood that complies with design, construction, and performance criteria of applicable national and local codes.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Hoods.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings:

1. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
2. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
3. Indicate performance, exhaust and makeup air airflow and pressure loss, at actual Project-site elevation.
4. Indicate method of attaching hangers to building structure.
5. Show exhaust and makeup air ducts, and fittings connecting to hoods.
6. Show water-supply and drain piping.
7. Show control cabinets.
8. Show fire-protection piping, actuation devices, and manual control devices.
9. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
10. Wiring Diagrams: Power, signal, and control wiring.

B. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

1. Relative location of ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings to hoods and accessory equipment.
2. Roof framing and support members for duct penetrations.
3. Ceiling suspension assembly members.
4. Size and location of initial access modules for acoustical tile.

1.5 CLOSEOUT SUBMITTALS

A. Field test reports.

1.6 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. NSF Compliance: Fabricate hoods according to NSF 2, "Food Equipment."

D. SMACNA Compliance:

1. Fabricate hoods to comply with SMACNA's "HVAC Duct Construction Standards: Metal and Flexible," second edition.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 COORDINATION

A. Coordinate equipment layout and installation with other Work, including light fixtures, HVAC equipment, and fire-suppression system components.

PART 2 - PRODUCTS

2.1 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 304.

1. Minimum Thickness: 0.03 inch.
2. General: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
3. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
4. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).
5. Exposed Surfaces: ASTM A 480/A 480M, No. 4 finish (bright, directional polish).
6. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, exposed matte finish.

C. Galvanized Steel Sheet: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

1. Minimum Thickness: 0.03 inch.

D. Zinc-Coated Steel Shapes: ASTM A 36/A 36M, zinc coated according to ASTM A 123/A 123M requirements.

E. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR, Section 177.2600, for use in areas that come in contact with food.

1. Color: As selected by Architect from manufacturer's full range.
2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

F. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.

G. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and passes testing according to UL 710.

2.2 HOOD FABRICATION, GENERAL

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.

1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.

B. For metal butt joints, comply with SMACNA's "Kitchen Equipment Fabrication Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.

G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.

I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.

J. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Equipment Fabrication Guidelines."

K. Fabricate enclosure panels to ceiling and wall as follows:

1. Fabricate panels on three exposed sides with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.

2.3 WALL RESIDENTIAL KITCHEN HOOD FABRICATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Commercial Kitchen Hoods:

a. Greenheck Group Company, WRH-60.
b. Grease Master.
c. Gaylord Industries; a part of the ITW Food Equipment Group.

B. Compliance: Fabricate hoods to comply with UL 507 and SMACNA's "HVAC Duct Construction Standards: Metal and Flexible," second edition.

C. Fabricate hoods with stainless steel.

D. Hood Configuration: Exhaust only.

E. Filter Type: Captrate Solo Filter or Standard Baffle.

F. Hood Style: Wall-mounted canopy.

G. Light Fixtures: UL-listed, LED lamps with lenses sealed vaportight. Wiring shall be installed in stainless-steel conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc on cooking surface below hood.

1. Switches shall be mounted on wall adjacent to hood.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install hoods level and plumb.

B. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.
2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication" Article.

C. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, grease removal devices, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

D. Make cutouts in hoods where required to run service lines and to make final connections.

E. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

F. Install hoods to operate free from vibration.

G. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

H. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

I. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20, 21, and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine with clearance to allow service and maintenance.

C. Install washer-water drain piping full size of hood connection to an adjacent floor drain or floor sink.

D. Duct Connections: Comply with applicable requirements in Division 23 Section "Duct Accessories" for flexible connectors on makeup air supply duct. Weld exhaust-duct connections.

E. Fire-Suppression Piping: Install piping connections for remote-mounted suppression systems according to NFPA 17, "Wet Chemical Extinguishing Systems."

F. Ground equipment.

G. 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.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

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. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
4. Perform hood performance tests required by authorities having jurisdiction.
5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

D. Prepare test and inspection reports.

3.5 CLEANING

A. Remove protective coverings and clean and sanitize hoods and associated services, both inside and out, according to manufacturer's written instructions.

B. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hoods.

END OF SECTION 233813

SECTION 235100 - BREECHING, CHIMNEYS, AND STACKS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Metal Ducts” for double-wall factory fabricated grease duct.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Type B and BW vents.
2. Special gas vents.

1.3 INFORMATIONAL SUBMITTALS

A. Shop Drawings: For vents, breeching, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers, and location and size of each field connection.

2. Provide engineered sizing data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

B. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedule 40 Pipe.

1. CPVC Schedule 40 Fittings: ASTM F 438, socket type.
2. CPVC Solvent Cement: ASTM F 493.

2.2 LISTED TYPE B AND BW VENTS

A. Manufacturers:

1. AMPCO; American Metal Products; Hart & Cooley, Inc.; Model AmeriVent Type B Vent.
2. DuraVent, Inc.; dba DuraVent/Security Chimneys.
3. Metal-Fab, Inc.; Model M.
4. Selkirk Inc.; Hart & Cooley, Inc.; Selkirk Metalbestos; Model RV for 3” to 8” diameter, Model DF for 10” to 24” diameter, and Model QC for 26” to 48” diameter.
5. Van-Packer Co.; Model B-Vent.

B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B, or 550 deg F continuously for Type BW; with neutral or negative flue pressure, complying with NFPA 211; and suitable for certified gas-fired appliances.

C. Construction: Inner shell and outer jacket separated by at least 1/4-inch airspace.

D. Inner Shell: ASTM B 209 aluminum for vents less than 10 inches in diameter. ASTM A 666, Type 430 stainless steel for vents 10 to 24 inches in diameter. ASTM B 209 aluminum for vents larger than 24 inches in diameter.

E. Outer Jacket: Galvanized steel for vents less than 10 inches in diameter. Aluminized steel indoors and Type 304 stainless steel outdoors for vents 10 to 24 inches in diameter. Galvanized steel for vents larger than 24 inches in diameter.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Round Chimney Top designed to exclude 98 percent of rainfall. A “Pointed Hat” stack cap is not acceptable.

2.3 LISTED SPECIAL GAS VENT

A. Manufacturers:

1. Cleaver-Brooks, Inc.; CBHL.
2. DuraVent, Inc.; dba DuraVent/Security Chimneys.
3. Heat-Fab, Inc.; Hart & Cooley, Inc.; Model Saf-T Vent CI.
4. Metal-Fab Inc.; Model Corr/Guard.
5. Schebler Chimney Systems; eVent.
6. Selkirk Inc.; Hart & Cooley, Inc.; Selkirk Metalbestos; Model DCV.
7. Van-Packer Co.; Model CS.

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 550 deg F continuously, with positive, negative, or neutral flue pressure, complying with NFPA 211 and suitable for condensing gas-fired appliances.

C. Construction: Inner shell and outer jacket separated by at least 3/32-inch airspace.

D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

E. Outer Jacket: Aluminized steel indoors and Type 304 stainless steel outdoors.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Round chimney top design to exclude 98 percent of rainwater. A “Pointed Hat” stack cap is not acceptable.
2. Termination: Adjustable wall thimble and horizontal termination with bird screen.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

B. Listed Special Gas Vent: Condensing gas appliances, and direct vented finned water-tube boilers and water heaters.

C. CPVC Plastic Pipe and Fittings: Condensing gas water heaters reaching sanitizing temperatures.

3.3 INSTALLATION OF LISTED VENTS, CHIMNEYS AND STACKS

A. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

B. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

C. Slope breeching down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breeching internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breeching, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

SECTION 235216 - CONDENSING BOILERS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Water Treatment for Closed-Loop Hydronic Systems” for corrosion inhibitors required for modular cast-aluminum condensing boilers.
4. Division 23 Section "Breeching, Chimneys, and Stacks.”

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, stainless steel vertical fire tube condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.

B. Source quality-control test reports.

C. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For boilers to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a NRTL acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL VERTICAL FIRE-TUBE CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AERCO International; Benchmark Series.
2. Cleaver-Brooks; CFC Series.
3. Fulton Boiler Works, Inc.; Endura Series.
4. HTP (Heat Transfer Products); UFT Series and EFT Series
5. Lochinvar Corporation; Knight KH Series Fire Tube Boilers,

B. Description: Factory-fabricated, -assembled, and -tested, wall mounted, vertical fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

C. Heat Exchanger: Corrosion-resistant stainless steel combustion chamber.

D. Pressure Vessel: Stainless steel with welded heads and tube connections.

E. Burner: Natural gas, forced draft.

F. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.

1. Motors: Comply with requirements specified in Division 20 Section "Motors."

a. 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.

G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Baked-enamel or powder-coated protective finish.
4. Insulation: Minimum 2-inch- thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.
6. Mounting base to secure boiler.

J. Characteristics and Capacities: Refer to Schedule on Drawings.

2.2 HOT-WATER BOILER TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping."

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.3 CONTROLS

A. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 200 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.

    a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

4. Provide contacts for connection to remote shutdown switch(es). Activation of remote shutdown switch shall cut power to the burner controls. Refer to Division 23 Section “Temperature Controls” for remote shutdown switches.

B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

2.4 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to lockable, nonfused disconnect switch.
5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

2.5 ACCESSORIES

A. Flue Side Condensate Neutralizer:

1. Description: Designed to raise the PH level of flue side condensate to near neutral prior to condensate entering the sanitary drainage system.
2. Materials: Neutralizer constructed of PVC pipe and fittings mounted on channel strut base with galvanized or stainless steel clamps and hardware; and charged with calcium carbonate.
3. Manufacturers:

    a. Axion Industries Ltd.; NeutraPal and NeutraPro Series.
    b. BKI Industries, Inc.; Acid Neutralizer Kits.
    c. J.J.M. Boiler Works; JM Neutralizing Tubes.
    d. Neutrasafe Corporation; Neutra-Safe Condensate Neutralizers.
    e. Any of the approved boiler manufacturers.

2.6 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install boilers level on concrete base. Concrete base is specified in Division 20 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 03.

B. Install natural gas-fired boilers according to NFPA 54.

C. Install propane-fired boilers according to NFPA 58.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from boiler flue gas condensate drain connection to condensate neutralizer, and from condensate neutralizer to nearest floor drain. Piping shall be PEX or CPVC at least full size of connection.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Boiler Venting:

1. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."

I. Ground equipment according to Division 26 Section "Grounding and Bonding."

J. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. 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 boilers.

END OF SECTION 235216

SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section “Hangers and Supports.”
4. Division 23 Section “Refrigerant Piping.”
5. Division 23 Section “Temperature Controls.”

1.2 SUBMITTALS

A. Product Data: For each packaged condensing unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Shop Drawings: For packaged condensing units. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which packaged condensing units will be attached.
2. Liquid and vapor pipe sizes.
3. Refrigerant specialties.
4. Piping including connections, oil traps, and double risers.
5. Compressors.
6. Evaporators.

D. Field quality-control reports.

E. Operation and Maintenance Data: For packaged condensing units to include in operation and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.4 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of curbs and penetrations is specified in Division 07 Section "Roof Accessories."

B. Coordinate location of piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 PACKAGED CONDENSING UNITS, AIR COOLED, 6 TO 120 TONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a United Technologies Company; Commercial HVAC Systems.
2. Daikin Applied; a member of Daikin Industries, Ltd.
3. Johnson Controls Incorporated/YORK Engineered Systems Group.
4. Trane; a Trane Technologies Brand.

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

1. Capacity Control: On-off compressor cycling.

D. Compressor: Hermetic or semi-hermetic rotary screw compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

1. Capacity Control: On-off compressor cycling.

E. Refrigerant: R-407C or R-410A.

F. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

G. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:

1. Permanently lubricated, ball-bearing motors.
2. Separate motor for each fan.
3. Dynamically and statically balanced fan assemblies.

H. Operating and safety controls include the following:

1. Manual-reset, high-pressure cutout switches.
2. Automatic-reset, low-pressure cutout switches.
3. Low-oil-pressure cutout switch.
4. Compressor-winding thermostat cutout switch.
5. Three-leg, compressor-overload protection.
6. Control transformer.
7. Magnetic contactors for compressor and condenser fan motors.
8. Timer to prevent excessive compressor cycling.

I. Accessories:

1. Low-Ambient Controller: Controls condenser fan speed to permit operation down to 0 deg F.
2. Gage Panel: Package with refrigerant circuit suction and discharge gages.
3. Part-winding-start timing relay, circuit breakers, and contactors.

J. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Non-fused disconnect switch, factory mounted and wired, for single external electrical power connection.
5. Condenser coil hail guard/security grille.

K. Capacities and Characteristics: As scheduled on the Drawings.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section "Motors."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate packaged condensing units according to AHRI 340/360.

B. Testing Requirements: Factory test sound-power-level ratings according to AHRI 370.

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 packaged condensing units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where packaged condensing units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Install roof-mounting units on roof mounted equipment supports specified in Division 20 Section "Hangers and Supports."

C. Vibration Isolation: Mount packaged condensing units on rubber pads with a minimum deflection of 1/4 inch. Vibration isolation devices and installation requirements are specified in Division 20 Section "Mechanical Vibration Controls."

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Comply with requirements for piping in other Division 20 and 23 Sections.

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

C. Connect refrigerant piping to air-cooled packaged condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping."

3.4 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, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Packaged condensing units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 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 and perform the following:

a. Inspect for physical damage to unit casing.
b. Verify that access doors move freely and are weathertight.
c. Clean units and inspect for construction debris.
d. Verify that all bolts and screws are tight.
e. Adjust vibration isolation and flexible connections.
f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow and air temperature rise over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain packaged condensing units.

END OF SECTION 236200

SECTION 237210 - LIGHT COMMERCIAL AIR-TO-AIR ENERGY RECOVERY 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.

B. Related Sections include the following:

1. Division 07 Section "Roof Accessories" for roof curb installation.
2. Division 20 Section “Mechanical General Requirements.”
3. Division 23 Section "Temperature Controls" for control wiring and control devices connected to energy recovery units.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other Work. For installed products indicated to comply with design loads, include structural analysis data.
2. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain air-to-air energy recovery units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-to-air energy recovery units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. AHRI Compliance: Ratings for energy recovery devices shall comply with AHRI 1060, “Rating Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.”

E. ASHRAE Compliance:

1. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

F. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

G. UL Compliance:

1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling 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 Division 07 Section "Roof Accessories."

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 ENERGY RECOVERY VENTILATORS

A. Manufacturers:

1. Venmar CES; an affiliate of CES Group.
2. Thermal Corporation; a Division of Nailor International, Inc.
3. Ruskin Company.
4. RenewAire LLC; member of the Soler & Palau Ventilation Group.
5. Loren Cook Company.
6. Greenheck.
7. Dunham-Bush, Inc.
8. American ALDES Ventilation Corporation.

B. Description: Factory assembled and tested; designed for interior installation; consisting of energy recovery core heat exchanger, supply-air fan, exhaust-air fan, filters, dampers, basic unit controls and interface to BAS.

C. Casing: Manufacturer's double-wall galvanized sheet metal construction with exterior enamel paint finish. Units having single-wall casing construction are not acceptable.

1. Finish able to withstand minimum 500-hour salt spray test in accordance with ASTM B117.
2. Hinged access doors with neoprene gaskets for inspection and access to internal parts.
3. Minimum 1-inch- thick thermal insulation.
4. Perforated-metal liner on supply-air fan discharge section.
5. Knockouts for electrical and piping connections.
6. Exterior condensate drain connection.
7. Lifting lugs.

D. Supply-Air Fan: Airfoil, or backward inclined as scheduled, centrifugal, direct-driven or V-belt driven with fixed motor sheaves, grease-lubricated ball bearings, and motor. Mount fan and motor assembly on base with elastomeric isolator pads.

E. Exhaust Fan: Forward curved or airfoil, centrifugal, belt driven with adjustable motor sheaves, grease-lubricated ball bearings, and motor. Mount fan and motor assembly on base with elastomeric isolator pads.

F. Filters: Size, type, and rating as scheduled on the Drawings, in filter racks or galvanized-steel frames as required by filter type.

1. Air Filter and Filter-Holding System Manufacturers:

a. AAF International.
b. ECO Air.
c. Farr Co.
d. Flanders Filters, Inc.

G. Electrical:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. Single-point, field-power connection to nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as indicated on the Drawings or 14,000 A, whichever is greater.

a. Branch power circuit to each motor, dedicated electrical load, and controls with disconnect switch or circuit breaker.

1) NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

b. NEMA ICS 2, Class A, full-voltage, non-reversing motor controller, hand-off-auto switch, and overcurrent protection for each motor.
c. Control-circuit transformer with primary and secondary side fuses.

3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

H. Unit Controls: Solid-state control board and components contain at least the following features:

1. Supply-air fan control relay.
2. Exhaust air fan control relay.
3. Default control to ensure proper operation after power interruption.
4. Service relay output.
5. Unit diagnostics and diagnostic code storage.
6. Field-adjustable control parameters.

I. BAS Communication Link (with or without unit manufacturer provided Programmable DDC): Stand-alone control module providing link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Division 23 Section "HVAC Instrumentation and Controls."

J. Accessories:

1. Service Outlets: 115-V, ground-fault, circuit-interrupter type, factory wired such that outlet shall remain energized even if the unit main disconnect is open.
2. Dirty-filter switch.

2.3 MOTORS

A. Comply with requirements in Division 20 Section "Motors."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hoist, transport, and rig units or their shipping sections into position following procedures recommended by the manufacturer.

B. Install units level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI - SMACNA Guideline B.

C. Install units with clearances for service and maintenance.

D. Deliver roof curbs and equipment supports to site for installation under Division 07. Install rooftop units on equipment curbs and supports specified. Secure units to curb support with anchor bolts.

E. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions. Refer to Division 20 Section “Basic Mechanical Materials and Methods” for base requirements. Coordinate wall penetrations and flashing with wall construction.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

G. Pipe condensate drains from heat exchanger units and drain pans to nearest floor drain or roof drain. Use same size piping as condensate drain connection. For equipment located outdoors, insulate and provide electrical heat trace for condensate drains.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Units shall be provided complete for single point connection to hydronic piping system.

B. Install piping adjacent to machine to allow service and maintenance.

C. Duct and fan installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts, fittings, and specialties.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

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 field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 237210

SECTION 237413 - MODULAR AND SEMI-CUSTOM CENTRAL-STATION AIR-HANDLING 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air handling equipment.
4. Division 23 Section “Packaged Compressor and Condenser Units.”

1.2 SUMMARY

A. This Section includes indoor, central-station air-handling units AHU-1 with the following components and accessories as scheduled on the Drawings:

1. Direct-expansion cooling.
2. Hot water heating coils.
3. Energy recovery.
4. Supply fan.
5. Exhaust fan.
6. Economizer outdoor- and return-air damper section.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 125 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/240 where "L" is the unsupported span length within completed casings.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each air handling unit, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

1.6 INFORMATIONAL SUBMITTALS

A. 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.

1. Wiring Diagrams: Power, signal, and control wiring.

1.7 CLOSEOUT SUBMITTALS

A. Field quality control test reports.

B. Operation and Maintenance Data: For air handling units to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of central station air-handling units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. AHRI Certification: Indoor air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.

C. AHRI Compliance:

1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for air handling units.
2. Comply with AHRI 270 for testing and rating sound performance for outdoor units.

D. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

E. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

F. UL Compliance: Comply with UL 1995.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

1.9 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.

1.10 EXTRA MATERIALS

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. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.
3. Gaskets: One set for each access door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON, Inc.
2. Carrier; Div. of United Technologies Corp.; 39 Series.
3. Daikin Applied; a member of Daikin Industries, Ltd.
4. JCI/YORK International Corporation.
5. Nortek Air Solutions; Ventrol, Venmar, and Temtrol Divisions.
6. Trane; a Trane technologies Brand; Performance Climate Changer.
7. VTS America, Inc.; American Ventus.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. Casing panels shall be solid double-wall construction of pre-painted galvanized steel inner and outer panels and foam insulation. Casing deflection shall not exceed a 1 to 200 ratio when subject to an internal pressure of plus or minus 5-inch wg and shall exhibit no permanent deformation at plus or minus 9-inch wg.

B. Exterior Casing Material: Galvanized steel, knockouts with grommet seals for electrical and piping connections, and lifting lugs.

C. Inner Casing Fabrication Requirements:

1. Fan sections shall have acoustic interior sheet uniformly perforated with 1/16 or 3/32 inch holes to produce approximately 20 percent open area.
2. Floor Plate: Galvanized steel, 0.1382 inch thick.

D. Access Requirements: Removable panels or hinged access doors with neoprene gaskets for inspection and access to internal components.

E. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: Foam panels, ASTM C 1071.
2. Thickness: 2 inches.
3. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
4. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
5. Location and Application: Encased between outside and inside casing.

F. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded coupling or nipple.

G. Casing Finish:

1. External surface of unit casing prepared and coated with a minimum 1.5 mil enamel finish or equal.
2. Manufacturer's standard color.

2.3 FANS

A. Centrifugal Fans (Exhaust Fan):

1. General: Select fans to avoid instability in service and compute outlet areas to outlet velocities in accordance with AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency.
2. Description: AMCA certified, factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
3. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.

    a. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
    b. Spun inlet cone with flange.
    c. Outlet flange.

4. Fan Wheels: Airfoil, backward-inclined, or forward-curved as indicated on Drawings.

    a. Airfoil Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

5. Accessories:

    a. Scroll Access Doors: For fans larger than 18 inches in diameter, shaped to conform to scroll, with quick-opening latches and gaskets.
    b. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
    c. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
    d. Belt guard.

6. Fan Construction:

    a. Housing Material: Reinforced steel. Metal thickness not less than minimum specified by AMCA for the class of service.
    b. Wheel Material: Steel. Metal thickness not less than minimum specified by AMCA for the class of service.
    c. Vibration Isolators: Spring isolators having a static deflection of 1 inch.
    d. Refer to schedules on Drawings for additional requirements.

B. Plenum/Plug Fans (Supply Fan):

1. General: Select fans to avoid instability in service and compute outlet areas to outlet velocities in accordance with AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency.

2. Description: AMCA certified, factory-fabricated, -assembled, -tested, and -finished, unhoused, belt-driven centrifugal plenum/plug fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
3. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
4. Accessories:

    a. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
    b. Direct Drive Plenum Fans:

        1) Variable frequency drives.
        2) Motor protection box for motor current protection with a single VFD driving multiple motors.
        3) Airflow measuring piezo ring.
        4) Motor shaft grounding ring.

5. Fan Construction:

    a. Wheel Material: Steel. Metal thickness not less than the minimum specified by AMCA for the class of service.
    b. Vibration Isolators: Spring isolators having a static deflection of 1 inch.
    c. Refer to schedules on Drawings for additional requirements.

C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

2.4 COILS

A. On outdoor units provide pipe housing on side of AHU where indicated on plans.

B. Water Coils:

1. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.
3. Source Quality Control: Factory tested to 300 psig.
4. Tubes: ASTM B 743 copper, minimum 0.020 inch wall thickness, and minimum 0.50 inch diameter.
5. Fins: Aluminum, minimum 0.010 inch thick.
6. Headers: Cast iron with cleaning plugs, and drain and air vent tappings or seamless copper tube with brazed joints, prime coated.
7. Frames, Hot Water Coils: Galvanized-steel channel frame, minimum 0.0625 inch thick.

C. Direct-Expansion Cooling Coils: Fabricated according to AHRI 410, connected with brazed fittings.

1. Capacity Reduction: Circuit for interleaved control.
2. Tubes: Copper.
3. Fins: Aluminum with fin spacing as scheduled on Drawings.
4. Fin and Tube Joint: Mechanical bond.

5. Suction and Distributor: Seamless copper tube with brazed joints.
6. Frames: Stainless steel, 0.0625 inch.
7. Ratings: Design tested and rated according to ASHRAE 33 and AHRI 410.

    a. Working-Pressure Rating: 300 psig.

8. Source Quality Control: Test to 450 psig and to 300 psig underwater.

2.5 ENERGY RECOVERY SECTION

A. Heat Wheels:

1. Casing: Constructed to meet the applicable requirements for central-station air handling units.

    a. Integral purge section.
    b. Casing seals on periphery of rotor, on duct divider, and on purge section.
    c. Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.

2. Rotor: Corrugated polymer segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive silica-gel desiccant coating. Construct media for passing maximum 1200-micrometer solids and maximum 0.04 percent cross contamination by volume of exhaust air. Drive rotor with belt around outside of rotor.
3. Drive: Fractional horsepower motor and gear reducer, with speed changed by adjustable variable-frequency controller.
4. Controls: Starting relay, factory mounted and wired, and manual motor starter for field wiring.
5. Controls: Panel factory mounted and wired to motor, with airstream thermostat and adjustable variable-frequency controller for field wiring; with pilot-light indication of rotor rotation and provisions for setting maximum and minimum speed.

2.6 FILTER SECTION

A. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.

B. Filters: Size, type, and rating as scheduled on the Drawings. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Air Filter Manufacturers:

    a. AAF International.
    b. Camfil Farr Co.
    c. ECO Air.
    d. Filtration Group, Inc.
    e. Flanders Filters, Inc.

2.7 DAMPERS

A. Outdoor-and Exhaust Air Dampers will be provided by the Temperature Controls Contractor.

B. Mixed Air Damper: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.

2.8 ELECTRICAL REQUIREMENTS

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to air handling unit.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
5. Minimum SCCR according to UL 508 shall be as indicated on the Drawings or 14,000 A**,** whichever is greater.
6. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:

a. NEMA KS 1, heavy-duty, nonfusible switch.
b. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.9 CONTROLS

A. Control equipment is specified in Division 23 Section "Temperature Controls," and sequence of operation is indicated on the Drawings.

2.10 ACCESSORIES

A. Service Outlets: Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Outlet shall remain energized even if the unit main disconnect is open.

B. Lighting: Vapor-proof, marine-type, 100-watt service lights in segments indicated on Drawings. Lights shall be wired to single on/off toggle switch which brings all lights on at once. Lights shall be operable even if the main disconnect is open.

C. Filter Differential Pressure Switch: With sensor tubing on either side of filter. Set for final filter pressure loss.

2.11 CAPACITIES AND CHARACTERISTICS

A. Refer to Schedule on Drawings.

2.12 SOURCE QUALITY CONTROL

A. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

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 air handling units.

B. Examine roughing-in for air handling units to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where air handling units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION (INDOOR UNITS)

A. Concrete Bases: Install floor mounting units on 4-inch- high concrete bases. See Division 20 Section "Basic Mechanical Materials and Methods" for concrete base materials and fabrication requirements.

B. Hoist, transport, and rig units or their shipping sections into position following procedures recommended by manufacturer.

C. Install indoor air-handling units with the following vibration-control devices. Vibration-control devices are specified in Division 20 Section "Mechanical Vibration Controls."

1. Units with Internally Isolated Fans:

a. Floor-Mounted Units: Support on concrete bases using neoprene pads. Secure units to anchor bolts installed in concrete bases.

2. Units without Internally Isolated Fans:

a. Floor-Mounted Units: Support on concrete bases using housed-spring isolators. Secure units to anchor bolts installed in concrete bases.

D. Arrange installation of units to provide access space around indoor air-handling units for service and maintenance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections.

B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

C. Install piping adjacent to air handling units to allow service and maintenance.

D. Duct installation requirements are specified in other Division 23 Sections. The following are specific connection requirements:

1. Connect supply ducts to air handling units with flexible duct connectors specified in Division 23 Section "Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

1. After installing air handling units 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.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 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 coils 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. Verify lubrication on fan and motor bearings.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Adjust fan belts to proper alignment and tension.

11. Start unit according to manufacturer's written instructions.

    a. Complete startup sheets and attach copy with Contractor's startup report.

12. Inspect and record performance of interlocks and protective devices; verify sequences.
13. Operate unit for an initial period as recommended or required by manufacturer.
14. Calibrate thermostats.
15. Adjust and inspect high-temperature limits.
16. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
17. Cooling System: Measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

18. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
19. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

20. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.

21. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing air handling units and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air handling units.

END OF SECTION 237413

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes ductless split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.

B. Products supplied but not installed under this Section:

1. Roof curbs and equipment rails.

1.3 ACTION 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.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For split-system air-conditioning units to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

E. Seasonal Energy-Efficiency Ratio (SEER): Minimum 13.

1.7 COORDINATION

A. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section “Roof Accessories.” Pipe Roof Penetration Enclosures are specified in Division 20 Section “Basic Mechanical Materials and Methods.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Single-Zone Split-System Air-Conditioning Units:

a. Airedale North America, Inc.
b. Carrier Corp.; United Technologies Corporation.
c. Daikin Applied; a member of Daikin Industries, Ltd.; Daikin AC.
d. Johnson Controls-Hitachi.
e. LG Electronics, HVAC Division.
f. Mitsubishi Electric & Electronics America, Inc.; HVAC Advanced Products Division.
g. Samsung Electronics.

2. Roof Curbs and Equipment Rails:

a. Pate Company (The).
b. Roof Products and Systems Corp.
c. ThyCurb; a division of THYBAR Corporation.

2.2 SINGLE-ZONE DUCTLESS SPLIT SYSTEM AIR CONDITIONER

A. Complete packaged air conditioning unit factory fabricated and tested.

B. Indoor Evaporator Section: Complete with fan section, motor, washable filter, condensate drain pan, field installed condensate pump, and direct expansion evaporator section. Include factory-installed float switch to detect high condensate water level and disable fan operation.

C. Air Cooled Condensing Section: Completely factory piped for single point connection of refrigerant lines. Condensing unit with propeller fan shall be matched to evaporator section to provide cooling capacity as scheduled on drawings.

D. Controls: Unit furnished with factory installed microprocessor controls. Provide wireless remote or unit mounted control or wall thermostat, which shall provide selection of all functions and control of room temperature set points. Furnish and install one mounting bracket for each wireless remote control.

E. Provide complete refrigerant piping circuit (including all piping specialties) sized in accordance with manufacturer's requirements to interconnect evaporator and condenser sections.

F. Wall-Mounting, Evaporator-Fan Components:

1. Cabinet: With removable panels for servicing, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
3. Fan: Direct drive, centrifugal fan.

4. Fan Motors: Comply with requirements in Division 20 Section "Motors."

    a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

5. Filters: Permanent, cleanable.

G. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Reciprocating or Scroll.
    b. Include refrigerant charge.
    c. Refrigerant: R-410A.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 0 deg F. Include wind manufacturer's wind baffle accessory.

H. Control equipment is specified in Division 23 Section "Temperature Controls," and sequence of operation is indicated on the Drawings.

I. Thermostat: Wall-mounted low voltage type to control compressor and evaporator fan.

J. Automatic-reset timer to prevent rapid/short cycling of compressor.

2.3 ACCESSORIES

A. Roof Curbs and Equipment Rails:

1. Minimum 18 gage welded galvanized steel construction.
2. Integral base flange or plate.
3. Built-in fully mitered raised cant with step matching insulation thickness.
4. Factory installed insect and decay resistant wood nailer.
5. Top of curb or equipment support shall be level and extend a minimum of 8 inches above the top of the roof insulation.

B. Automatic Condensate Pump Units (Field Installed)

1. Manufacturers:

a. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
b. Beckett Corporation.
c. Hartell Pumps Div.; Milton Roy Co.
d. Hydromatic Pump Company; Division of Pentair Pump Group.

2. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls.

C. Wall Sleeve-Seal Systems:

1. Manufacturers:

a. Airex Manufacturing, Inc.; Pro-System Kit.

2. Description: Exterior wall seal system for HVAC refrigerant line set piping penetrations through the building envelope.

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. Deliver roof curbs and equipment support to site for installation under Division 07. Install roof-mounting compressor-condenser components on equipment supports specified. Anchor units to supports with removable, cadmium-plated fasteners. Install wind baffle according to manufacturer’s installation instructions.

D. Install and connect refrigerant tubing to components. Install tubing to allow access to unit. Evacuate and charge with refrigerant in accordance with manufacturers instructions.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections.

B. Install piping adjacent to unit to allow service and maintenance.

C. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. 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.

B. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238216 - HEATING AND COOLING COILS

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Sections for coils that are integral to air-handling units.

1.2 SUMMARY

A. This Section includes duct-mounted heating and cooling coils, and heating and cooling coils that are an integral part of air-handling units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each coil. Include rated capacity and pressure drop for each coil.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

PART 2 - PRODUCTS

2.1 WATER COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aerofin Corporation.
2. Carrier; a United Technologies Company.
3. Daikin Applied; a member of Daikin Industries, Ltd.
4. JCI/York International.
5. Luvata/Heatcraft Commercial/Industrial Products.
6. Nortek Air Solutions; Ventrol.
7. Precision Coils; a business of Unison Comfort Technologies.
8. Trane; a Trane Technologies Brand.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch wall thickness, and minimum 0.50 inch diameter.

F. Fins: Aluminum, minimum 0.010 inch thick.

G. Headers: Cast iron with cleaning plugs, and drain and air vent tappings or seamless copper tube with brazed joints, prime coated.

H. Frames, Hot Water Coils: Galvanized-steel channel frame, minimum 0.0625 inch thick.

2.2 REFRIGERANT COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aerofin Corporation.
2. Carrier; a United Technologies Company.
3. Daikin Applied; a member of Daikin Industries, Ltd.
4. JCI/York International.
5. Luvata/Heatcraft Commercial/Industrial Products.
6. Nortek Air Solutions; Ventrol.
7. Precision Coils; a business of Unison Comfort Technologies.
8. Trane; a Trane Technologies Brand.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure Rating: 300 psig.

D. Source Quality Control: Factory tested to 450 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch wall thickness, and minimum 0.50 inch diameter.

F. Fins: Aluminum, minimum 0.010 inch thick.

G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.

H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick.

2.3 DRAIN PANS

A. Description: For cooling coils, IAQ compliant formed to slope from all directions to the drain connection as required by ASHRAE 62.

B. Construction: Minimum 22 gage, Type 304 stainless steel with welded joints, positively sloped a minimum of 1/8 inch per foot, with threaded drain connection at lowest point of pan. Intermediate pans piped to the primary drain pan are required for all stacked cooling coils.

C. Provide intermediate coils with 3 inch deep pans for each tiered coil bank. Top pan shall extend 6 inches beyond face of coil and bottom pan shall extend not less than 12 inches beyond face of coil. Where more than two pans are used, pan extension shall be proportional.

D. Supports: Same material as pans.

E. Pipe pan drain to floor drain. A deep seal trap shall be installed on the drain pipe from the pans.

F. Include factory-installed float switch to detect high condensate water level and disable associated fan operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install minimum 22 gage, Type 304 stainless-steel drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Straighten bent fins on air coils.

E. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Temperature Controls," and other piping specialties are specified in Division 23 Section "Hydronic Piping."

D. Connect refrigerant piping according to Division 23 Section "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 238216

SECTION 238219 - FAN-COIL 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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS

A. BAS: Building automation system.

B. IAQ: Indoor air quality.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

1. Wiring Diagrams: Power, signal, and control wiring.

B. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension components.
2. Structural members to which fan-coil units will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For fan-coil units to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

A. Coordinate layout and installation of fan-coil units and system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

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 BLOWER COIL UNITS

A. Manufacturers:

1. Carrier; a United Technologies Company.
2. Daikin Applied; a member of Daikin Industries, Ltd.
3. Enviro-Tec; by Johnson Controls, Inc.
4. Trane; a Trane Technologies Brand.
5. United Electric Company L.P. dba Magic Aire.
6. USA Coil & Air.

B. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: Minimum 1/2-inch thick dual-density coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

E. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.

1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
3. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

F. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, 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.

H. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

I. Motors: Comply with requirements in Division 20 Section "Motors."

J. Control devices and operational sequence are specified in Division 23 Sections "Temperature Controls" and indicated on "Sequence of Operation" on the Drawings.

K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

L. Capacities and Characteristics: Refer to schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect condensate drain to indirect waste.

B. Water Piping: Unless otherwise indicated:

1. Install union or flange and isolation valve on supply-water connection.
2. Install union or flange and calibrated balancing valve or PICCV as indicated on the Drawings on return-water connection.
3. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

C. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

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.

END OF SECTION 238219

SECTION 238240 - CENTRIFUGAL FAN CABINET UNIT HEATERS (HOT WATER)

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. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. 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.

1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Location and arrangement of piping valves and specialties.
4. Location and arrangement of integral controls.
5. Wiring Diagrams: Power, signal, and control wiring.

B. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

1.4 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For cabinet unit heaters to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; United Technologies Corporation.
2. Daikin Applied; a member of Daikin Industries, Ltd.
3. Hydro-Air Components Inc.; Zehnder Rittling.
4. Modine Manufacturing Company.
5. Sterling Radiator; a Mestek Company.
6. Trane; a Trane Technologies Brand.
7. Vulcan Radiator; a Mestek Company.

B. Description: A factory-assembled and -tested unit complying with AHRI 440.

C. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall have erosion-resistant coating to prevent erosion of glass fibers.

1. Thickness: Minimum 1/2 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
2. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
3. Recessing Flanges for Units That Are Semirecessed or Fully Recessed: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base for Surface, Vertical, Wall-Mounting Units: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber Treated with Adhesive: Throw-away type 80 percent arrestance and 5 MERV.

F. Hot-Water Coil: 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.

G. Fan and Motor Board: Removable.

1. Fan: Forward curved, double-width centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 20 Section "Motors."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

H. Electrical Connection: Factory wire motors and controls for a single field connection.

I. Capacities and Characteristics: Refer to Schedule on Drawings.

2.2 UNIT CONTROLS

A. Control devices are specified in Division 23 Section "Temperature Controls," and operational sequences are indicated on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before cabinet unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cabinet unit heaters to comply with NFPA 90A.

B. Suspend cabinet unit heaters from structure with elastomeric hangers.

1. Vibration isolators are specified in Division 20 Section "Mechanical Vibration and Controls."

C. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Comply with safety requirements in UL 1995.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 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. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 238240

SECTION 238241 - PROPELLER FAN UNIT HEATERS – STEAM, HOT WATER, ELECTRIC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes propeller fan unit heaters with hot-water coils.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each unit type and configuration.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Submit the following for each unit type and configuration:

1. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Coordination Drawings: Plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which unit heaters will be attached.
3. Other items, including the following:

a. Lighting fixtures.
b. Sprinklers.
c. Ductwork.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hot-Water Unit Heaters:

a. Daikin Applied; a member of Daikin Industries, Ltd.
b. Dunham-Bush, Inc.
c. Hydro-Air Components; Zehnder Rittling.
d. Modine Manufacturing Company.
e. Sterling Radiator, a Mestek Company.
f. Trane Inc.; a Trane Technologies Brand.
g. Vulcan Radiator, a Mestek Company.

2.2 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

2.3 CASING

A. Cabinet: Removable panels for maintenance access to controls.

B. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

C. Discharge Louver: Four-way adjustable louvers for horizontal units and adjustable pattern diffuser for projection units.

2.4 COILS

A. Test and rate propeller unit-heater coils according to ASHRAE 33.

B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, 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 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

2.5 FAN

A. Propeller type, aluminum wheel directly mounted on motor shaft in the fan venturi.

2.6 FAN MOTORS

A. Comply with requirements in Division 20 Section "Motors."

B. Motor Type: Permanently lubricated, multispeed.

2.7 CONTROLS

A. Control Devices:

1. Unit-mounted fan-speed switch.
2. Wall-mounting thermostat.

2.8 CAPACITIES AND CHARACTERISTICS

A. Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before propeller unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters level and plumb.

B. Install propeller unit heaters to comply with NFPA 90A.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers.

1. Hanger rods and attachments to structure are specified in Division 20 Section "Hangers and Supports."
2. Vibration hangers are specified in Division 20 Section "Mechanical Vibration Controls."

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Comply with safety requirements in UL 1995.

D. Hot Water Piping: Unless otherwise indicated:

1. Install union and isolation valve on supply-water connection.
2. Install union and calibrated balancing valve or PICCV as indicated on the Drawings on return-water connection.
3. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and report results in writing:

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 238241

SECTION 238317 - SNOW MELTING AND FLOOR HEATING

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. Division 07 Section "Penetration Firestopping" for materials and installation requirements for sealing pipe penetrations through fire and smoke barriers.
2. Division 20 Section “Mechanical General Requirements.”
3. Division 20 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
4. Division 20 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.
5. Division 20 Section "Mechanical Identification" for labeling and identifying piping and equipment.
6. Division 23 Section "General-Duty Valves for HVAC."
7. Division 23 Section “Water Treatment for Closed-Loop Hydronic Systems” for glycol and related glycol fill equipment.

8. Division 23 Section "Hydronic Piping" for pipes and connections to hydronic systems.
9. Division 23 Section “Condensing Boilers.”
10. Division 23 Section "Temperature Controls" for thermostats, controllers, automatic control valves, and sensors.

1.2 SUMMARY

A. This Section specifies components required for snow melting systems, including pipes, fittings, piping specialties, and controls.

B. Work includes furnishing all labor, materials and equipment necessary to install snow melting system(s) as indicated on the Drawings and as specified in this Section.

1.3 DEFINITIONS

A. PEX: Crosslinked polyethylene.

1.4 PERFORMANCE REQUIREMENTS

A. Retain the services of a company specializing in snow melting systems to design, and furnish the complete snow melting system.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of radiant heating pipe, fitting, manifold, specialty, and control.

1. For radiant heating piping and manifolds, include pressure and temperature rating, oxygen-barrier performance, fire-performance characteristics, and water flow and pressure drop characteristics.

1.6 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

1. Shop Drawing Scale: Minimum 1/4 inch = 1 foot.

B. Delegated-Design Submittal: For snow melting systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For radiant heating piping valves and equipment to include in operation and maintenance manuals.

B. Written sequence of operation.

1.8 QUALITY ASSURANCE

A. Complete snow melting system shall be designed and provided by a firm regularly engaged in providing commercial snow melting systems and having a minimum of 10 completed installations. Submit documentation to Mechanical Engineer.

PART 2 - PRODUCTS

2.1 SYSTEM SUPPLIER

A. Subject to compliance with requirements, complete snow melting system shall be designed and provided by one of the following:

1. Comfort Engineering Solutions LLC; Watts Radiant; Chesterfield, MI; Phone: 586-421-2400.
2. Emerson Swan; A Swan Group Company; Watts Radiant; Livonia, MI; Phone: 877-791-7926.
3. H.S. Buy Van Associates, Inc.; Uponor Wirsbo; Auburn Hills, MI: Phone 248-852-7610
4. J.W. Sales, Inc.; Legend Radiant Products; Auburn Hills, MI; Phone: 248-745-8590.
5. Michigan Air Products; Rehau; Troy, MI; Phone: 248-837-7000.
6. R.L. Deppmann Company; MrPEX Systems Inc.; Southfield, MI; Phone: 248-354-3710
7. Thaw-Pak Snow Melting and Radiant Heating; Performance Engineering Group; Livonia, MI; Phone: 734-266-5300.
8. Viega North America, ProRadiant and S-no-Ice.

2.2 PEX PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Infloor Radiant Heating Inc.
2. MrPEX Systems Inc.
3. REHAU.
4. ROTH Industries, Inc.
5. Uponor Wirsbo Co.
6. Vanguard Piping Systems, Inc.; a Viega Company.
7. Viega North America.
8. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.
9. Zurn Plumbing Products Group; Zurn Radiant Heating Systems.

B. Pipe Material: PEX plastic in accordance with ASTM F 876.

C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F in accordance with DIN 4726.

D. Fittings: ASTM F 1807, metal-insert type with copper crimp rings and matching PEX tube dimensions; or plastic-insert type cold expansion fittings and corresponding rings, material meeting requirements of ASTM F 1960; or metal insert and cold jointing compression system meeting ASTM F 2080.

E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.3 DISTRIBUTION MANIFOLDS AND ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Infloor Heating Systems.
2. MrPEX Systems Inc.
3. Rehau Inc.
4. ROTH Industries, Inc.
5. Thaw-Pak Snow Melting and Radiant Heating Systems.
6. Vanguard Plastics, Inc.; a Viega Company.
7. Viega North America.
8. Uponor Wirsbo Co.
9. Watts Radiant, Inc.; a Division of Watts Water Technologies, Inc.
10. Zurn Plumbing Products Group; Zurn Radiant Heating Systems.

B. Manifold: Minimum NPS 1, brass, copper, anodized aluminum, or stainless steel.

C. Main Shutoff Valves:

1. Factory installed on supply and return connections.
2. Ball valve meeting requirements specified in Division 23 Section “General Duty Valves for HVAC.”

D. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Key furnished with valve, or screwdriver bit.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

E. Balancing Valves:

1. Body: Bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
7. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
8. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

F. Zone Control Valves (as required on Drawings):

1. Body: Bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Actuator: Replaceable electric motor.
6. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

G. Thermometers: Refer to Division 20 Section “Meters and Gages.”

H. Mounting Brackets: Copper, or plastic or copper-clad steel, where in contact with manifold.

2.4 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb, minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

2.5 BRAZED PLATE HEAT EXCHANGERS

A. Manufacturers:

1. Alfa Laval Thermal, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett; Xylem Inc.
4. GEA PHE Systems North America, Inc.; FP Series.
5. Mueller, Paul Company.

B. Configuration: Brazed assembly consisting of two end plates, one with threaded nozzles and pattern-embossed plates.

C. End-Plate Material: Type 316 stainless steel.

D. Threaded Nozzles: Type 316 stainless steel.

E. Plate Material: Type 316 stainless steel.

F. Brazing Material: Copper.

G. Capacity and Characteristics: Refer to schedule on the Drawings.

2.6 BOILER

A. Refer to Division 23 Section Condensing Boilers.

2.7 HYDRONIC PUMPS

A. Type and capacity as scheduled on the Drawings.

B. Refer to Division 23 Section “Hydronic Pumps” for additional requirements.

2.8 CONTROLS (SNOW MELTING)

A. Sequence of operation is indicated on the Drawings.

B. Temperature-control devices are specified in Division 23 Section "Temperature Controls."

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HBX Control Systems Inc.
2. Infloor Radiant Heating Inc.
3. REHAU.
4. Tekmar Control Systems, Ltd.
5. Uponor Wirsbo Co.
6. Vanguard Piping Systems, Inc.; a Viega Company.
7. Viega North America; Advanced Snow Melt Control.
8. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.

D. Combination Ice and Snow, and Combination Temperature and Moisture Sensor:

1. Automatic control with manual on, automatic, and standby/reset switch.
2. Combination ice and snow; and combination temperature and moisture sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:

    a. Temperature Span: 34 to 44 deg F.
    b. Adjustable Delay Off Span: 30 to 90 minutes.
    c. Start Pump or Open Zone Control Valves: Following two-minute delay if ambient temperature is below set point and precipitation is detected.
    d. Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Contactor of sufficient size to control pumps and valves.
5. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control system workstation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive radiant heating piping for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure that surfaces and pipes in contact with radiant heating piping are free of burrs and sharp protrusions.
2. Ensure that surfaces and substrates are level and plumb.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of radiant heating piping for the applications described:

1. Piping in Exterior Pavement: PEX.

3.3 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated on Shop or Coordination Drawings.

B. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.

C. Connect radiant piping to manifold in a reverse-return arrangement.

D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.

E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Division 08 Section "Access Doors and Frames."

F. Refer to Division 23 Sections "Hydronic Piping" and “HVAC Water Treatment” for pipes and connections to hydronic systems and for glycol-solution fill requirements.

G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Division 07 Section "Through-Penetration Firestop Systems."

H. Piping in Exterior Pavement:

1. Secure piping in concrete by attaching pipes to reinforcement using cable ties.
2. Space cable ties a maximum of 18 inches o.c., and at center of turns or bends, to maintain required spacing.
3. Maintain 2-inch minimum cover.
4. Avoid crossing expansion or control joints. Where joints must be crossed, employ either of the following methods:

    a. Install a sleeve of 3/8-inch- thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
    b. Route tubing under the joint into the sand bedding material.

5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.

I. Revise locations and elevations as required to suit field conditions and ensure integrity of piping.

J. After system balancing has been completed, mark balancing valves to permanently indicate final position.

K. Perform the following adjustments before operating the system:

1. Open valves to fully open position.
2. Check operation of automatic valves.
3. Set temperature controls so all zones call for full flow.
4. Purge air from piping.

3.4 FIELD QUALITY CONTROL

A. Prepare radiant heating piping for testing as follows:

1. Open all isolation valves and close bypass valves.
2. Open and verify operation of zone control valves.
3. Flush with clean water, and clean strainers.

B. Tests and Inspections:

1. Leak Test: After installation, but prior to concrete placement, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning radiant heating piping components that do not pass tests, and retest as specified above.

D. Prepare a written report of testing.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain Snow Melting Systems.

END OF SECTION 238317

SECTION 260010 - ELECTRICAL GENERAL REQUIREMENTS

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 work of this section.

1.2 SUMMARY

A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 REFERENCES

A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. ANSI - American National Standards Institute; www.ansi.org.
2. ASTM - ASTM International; www.astm.org.
3. CSI - Construction Specifications Institute (The); www.csiresources.org.
4. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
5. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
6. NEC - National Electrical Code
7. NECA - National Electrical Contractors Association; www.necanet.org.
    a. NECA 1-2000, “Practices for Good Workmanship in Electrical Contracting (ANSI).”
8. NEMA - National Electrical Manufacturers Association; www.nema.org.
9. NETA - InterNational Electrical Testing Association; www.netaworld.org.
10. UL - Underwriters Laboratories Inc.; www.ul.com.

1.4 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test, and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.

1. Contract Documents are complementary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
2. The Contractor understands that the work herein described shall be complete in every detail.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State, and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.

1. Notify the Architect/Engineer if revisions to the Drawings or Specifications are required to conform to applicable ordinances, codes, or regulations. Identify the cost associated with these revisions in the bid.

C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county, and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Avoid interference with the work of other trades. Remove and relocate any work which in the opinion of the Owner’s Representatives causes interference.

1.5 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals, and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules, and regulations.

B. Comply with rules of local utility companies. Coordinate with the utility company supplying service to the installation and determine all devices including, but not limited to, all current and potential transformers, meter boxes, C.T. cabinets, and meters which will be required and include the cost of all such items and all utilities costs in proposal.

C. All work shall be executed in accordance with the rules and regulations outlined in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction that exceed code requirements, the Drawings and/or Specifications shall govern.

1.6 DRAWINGS

A. The Drawings show the location and general arrangement of equipment, electrical systems, and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes, and accessories as may be required to meet such conditions.

C. Deviations from the Drawings, apart from minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades, and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.7 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new, be standard products of manufacturers regularly engaged in the production of electrical equipment and be of the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with

the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

C. Where existing equipment is modified to include new switches, circuit breakers, metering, or other components, the new components shall be by the original equipment manufacturer and shall be listed for installation in the existing equipment. Where original equipment manufacturer components are not available, third-party aftermarket components shall be listed for the application and submitted to the engineer for approval. Reconditioned or salvaged components shall not be used unless specifically indicated on the drawings.

1.8 INSPECTION OF SITE

A. Visit the site, examine, and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.9 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information, and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

A. Submit project-specific submittals for review in compliance with Division 1.

B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.

C. If deviations (not substitutions) from the Contract Documents are deemed necessary by the Contractor, the details of such deviations, the reason for the deviation, and the resulting changes shall be included with the submittal for approval.

E. Submit for approval shop drawings for electrical systems or equipment indicated in other sections of electrical specs. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures).

1.11 COORDINATION DRAWINGS

A. Submit project specific coordination drawings for review in compliance with Division 1 Specification Sections.

1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Manual shall be provided on electronic media. All literature shall be combined in one document and shall be properly bookmarked with all applicable sections. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all electrical systems including, but not limited to:

1. Routine maintenance procedures.
2. Trouble-shooting procedures.
3. Contractor's telephone numbers for warranty repair service.
4. Submittals.
5. Recommended spare parts list.
6. Names and telephone numbers of major material suppliers and subcontractors.
7. System schematic drawings on 8-1/2" x 11" sheets.

1.13 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 01.

B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media which have been neatly marked to represent as-built conditions for all new electrical work. Modifications to original drawings shall be marked with a contrasting color so the marks are readily apparent.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as

they occur. The marked up field documents shall be available for review by the Architect, Engineer, and Owner at their request during construction.

1.14 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.

D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.15 WARRANTY

A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship, or failure to follow the contract documents.

B. Contractor shall be responsible for any temporary services including equipment and installation required to maintain operation as a result of any equipment failure or defect during warranty period.

C. File with the Owner all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.16 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

1.17 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. To ensure that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions; and to maintain the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange, and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.

B. Device Location:

1. Allow for wiring devices, control devices, and fire alarm devices to be relocated within a 10’ radius to accommodate final coordination with furnishings and other finish elements. Devices relocated prior to installation shall be done without additional cost to the project.

3.3 TEMPORARY SERVICES

A. Provide and remove upon completion of the project, following the general conditions and as described in Division 01, a complete temporary electrical and telephone service during construction.

3.4 CHASES AND RECESSES

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.5 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.

B. All cutting, patching, and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.6 EXCAVATION AND BACKFILLING

A. Provide all excavation, trenching, tunneling, dewatering, and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.

B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.

C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

D. Backfill all excavations inside building, under drives, and parking areas with well-tamped granular material. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

E. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen excavated material in such a way as to prevent settling.

3.7 EQUIPMENT CONNECTIONS

A. Make connections to equipment and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.8 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.9 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury, or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.10 EXTRA WORK

A. For additional electrical work which may be proposed or requested, furnish an itemized cost breakdown of material and labor required to complete the work. Proceed only after receiving a written authorization.

B. Before providing an itemized break-down for additional electrical work, submit unit prices for the following items: 1/2", 3/4", 1", 1-1/2" EMT conduit; #12, #10, #8, #6, #2 building wire; duplex receptacles, GFCI receptacles, data box and raceway, V4000 wiremold, and fittings, fire alarm audible/visual notification appliance and visual notification appliance, clocks and speakers, and other common electrical work which may be anticipated for any future revisions. These unit costs, once agreed to, shall be applied to additions and deducts for all project change orders.

3.11 DRAWINGS AND MEASUREMENTS

A. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor’s responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 260010

SECTION 260519 - CONDUCTORS AND CABLES

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. Building wires and cables rated 600V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 SUBMITTALS

A. Field Quality-Control Test Reports

B. Submit letter of compliance (intent) for general building wire and cable. Provide product data for the following:

1. Metal-Clad Cable, Type MC
2. Power Cable for Variable Frequency Controlled Motors

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

D. Conductor Insulation:

1. Type THHN/THWN-2: Comply with UL 83.
2. Type THW/THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
3. Type XHHW-2: Comply with UL 44.

2.2 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

1. Allowed only for conductors used in feeders 100A and larger.

B. Manufacturers:

1. General Cable
2. Southwire

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Aluminum, complying with ASTM B 800 and ASTM B 801.

E. Conductor Insulation:

1. Type XHHW-2: Comply with UL 44.

2.3 POWER CABLE FOR VARIABLE FREQUENCY CONTROLLED MOTORS

A. Description: A factory assembly of three conductor cable with three symmetrical ground conductors, a continuous shield, an overall PVC jacket and a product specific connector and termination kit.

B. Manufacturers:

1. Service Wire Co.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1277
3. Comply with ICEA S-95-658/NEMA WC 70 for Type TC-ER Power Cable (for VFD application)
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit feeder.

E. Phase Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Bare copper.

G. Phase Conductor Insulation: Moisture resistant, flame retardant, cross linked polyethylene (2KV RHW-2) suitable for 90 deg C conductor temperature operation inf dry, damp and wet locations

H. Shield: Helically applied minimum 5 mils thick bare copper with minimum 50% overlap.

I. Armor: Steel or Aluminum, interlocked.

J. Jacket: Oil resistant PVC

K. Connector: Water-tight and UL listed for installation on supplied TC cable (tray cable) assembly.

1. Body material: nickel clad aluminum
2. Connector shall provide a 360-degree electrical bonding of the copper tape shield to the connector body.
3. Connection of the copper tape shield to the connector body shall be accomplished by an integral and self-retaining grounding collar that automatically provides a 360-degree connection as the connector is tightened.
4. The connector assembly shall be designed to ensure against loosening of threads due to vibration.
5. A UL listed chrome plated grounding and bonding locknut with a 360-degree knurled teeth connection shall be provided with each connector to secure and bond the connector to the inverter cabinet / motor termination box.
6. Tinned copper braids (minimum ¾ inches wide) with installation hardware to connect the copper tape shield to the inverter enclosure / back-panel and to the motor frame shall be provided as part of the cable system.

L. Termination Kit: Tinned copper braids (minimum ¾ inches wide) with installation hardware to connect the copper tape shield to cable core, to the inverter enclosure/back-panel, and to the motor frame shall be provided as part of the cable system.

1. Braid width shall be determined by cable core diameter size and shall be placed at a separation of 180 degrees.

2.4 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Refer to application schedule on the drawings

B. If providing aluminum feeders, contractor is responsible for providing correct feeder, equipment ground and conduit size based on voltage drop and any de-rating required.

C. Feeders and Branch Circuits: Solid or stranded for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

D. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).

E. Use conductor not smaller than 14 AWG for control circuits,

F. Where equipment is listed for use with copper conductors only, use copper conductors for the entire length of feeder.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Refer to application schedule on the drawings

B. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel wire-mesh strain relief device at terminations to suit application.

C. Fire Alarm Circuits: Type THHN/THWN-2, in raceway.

D. Class 1 Control Circuits: Type THHN/THWN-2, in raceway.

E. Class 2 Control Circuits: Type THHN/THWN-2, in raceway.

F. Connection between Variable Frequency Controllers and Motors: Use power cable for variable frequency-controlled motors. Install and terminate according to cable manufacturer’s recommendations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

H. Support communication cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

I. Neatly train and lace wiring inside boxes, equipment, and panelboards.

J. Provide a separate neutral conductor for each circuit unless multi-wire branch circuits are specifically indicated on the drawings.

K. Electrical Contractor shall be responsible for de-rating of conductors as required by N.E.C. when more than three current carrying conductors are installed in a single raceway or cable. Neutral conductors shall be considered current carrying conductors.

L. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.

M. Do not route conductors across roof without prior approval from engineer.

N. Install and terminate power cable for variable frequency- controlled motors according to cable manufacturer's recommendations.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
2. Use compression type terminations for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Clean conductor surfaces before installing lugs and connectors.

E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

F. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

G. Use piercing connector with insulating covers for conductor splices and taps, 8 AWG and larger only for taps to existing feeders. Do not use piercing connectors in new construction.

H. Use Sta-Kon connectors to terminate stranded conductors #10 AWG and smaller to screw terminals.

I. Use insulated spring wire connectors with plastic caps (wire nuts) for copper conductor splices and taps, 10 AWG and smaller. Push-in style connectors are not permitted.

J. Provide lugs suitable for bussing and conductor material used.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260533 "Raceways and Boxes."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping".

3.8 FIELD QUALITY CONTROL

A. Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Description: Test all feeders rated 100 A and above.
2. Visual and Mechanical Inspection

    a. Inspect cables for physical damage and proper connection in accordance with the one line diagram.
    b. Test cable mechanical connections with an infrared survey.
    c. Check cable color-coding against project Specifications and N.E.C. requirements.

3. Electrical Tests

    a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for 1 minute.
    b. Perform continuity test to insure proper cable connection.

4. Test Values

    a. Minimum insulation resistance values shall be not less than fifty mega-ohms.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements”.
2. Division 26 Section “Conductors and Cables”.

1.3 REFERENCES

A. ASTM B 3: Specification for Soft or Annealed Copper Wire.

B. ASTM B 8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.

C. ASTM B 33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

D. ASTM B 187: Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.

E. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

F. IEEE 142: Grounding of Industrial and Commercial Power Systems.

G. IEEE 1100 – 1992: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.

H. IEEE C2: National Electrical Safety Code.

I. NETA MTS – 2001: Maintenance Testing Specifications.

J. NFPA 70: National Electrical Code.

K. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.

L. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.

M. UL 467: Grounding and Bonding Equipment.

N. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

O. UL 486B: Wire Connectors for Use with Aluminum Conductors.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Data: For the following:

1. Ground rods.
2. Compression-type connectors.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Field Test Reports: Submit written test reports to include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
4. Indicate overall system resistance to ground.
5. Indicate overall Telecommunications system resistance to ground.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 26 “Electrical General Requirements”.

B. Accurately record actual locations of grounding electrodes and connections to building steel.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer to specification section “Electrical Testing.”

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.

1. Comply with UL 467.

C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

E. Comply with ANSI/TIA/EIA-607 “Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications”.

F. Comply with ANSI/IEEE 1100 -1992 “Powering and Grounding Sensitive Electronic Equipment”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors and Cables:

a. Refer to Division 26 Section “Conductors and Cables”.

2. Grounding Rods:

a. American Electric-Blackburn.
b. Apache Grounding/Erico Inc.
c. Chance/Hubbell.

3. Mechanical Connectors:

a. American Electric-Blackburn.
b. Burndy.
c. Chance/Hubbell.

4. Exothermic Connections:

a. Cadweld.

5. Compression-type Connectors:

a. Burndy HyGround
b. Blackburn EZ Ground.
c. Panduit.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."

B. Material: Aluminum, copper-clad aluminum, and copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, stranded, copper unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Conductor: Stranded copper conductor; size per the NEC.
2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.
3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; size per the NEC.

H. Aluminum Bonding Conductors: As follows:

1. Bonding Conductor: Stranded aluminum conductor; size per the NEC.
2. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; size per the NEC.

I. Ground Conductor and Conductor Protector for Wood Poles: As follows:

1. No. 4 AWG minimum, soft-drawn copper conductor.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

J. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

K. Telecommunications Main Grounding Busbar (TMGB)

1. 48” (min) x 4” x ¼” tin plated, copper busbar with three rows of ¼ x 20 tapped holes 3” on center.

L. Telecommunications Grounding Busbar (TGB)

1. 12” (min) x 2” x ¼” tin plated, copper busbar with two rows of ¼ x 20 tapped holes 3” on center.

M. Telecommunications Bonding Backbone (TBB)

1. Minimum No. 2 AWG insulated stranded copper.

N. Telecommunications Bonding Conductors

1. Minimum No. 6 AWG insulated stranded copper.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected for the specific application per manufacturer's written instructions.

D. Compression-Type Connectors: Pure, wrought copper, per ASTM B187.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

1. Size: 5/8 in diameter.
2. Length: 120 inches.

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDING

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

C. Underground Grounding Conductors: No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

D. In raceways, use insulated equipment grounding conductors.

E. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.

F. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

G. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

H. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a separate equipment grounding conductor with supply branch-circuit conductors. Bond pole and foundation reinforcing steel to equipment ground conductor.

J. Verify specific equipment grounding requirements with the manufacturer’s recommendations.

3.2 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations

1. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
2. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond

electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding 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 or UL 486B as applicable.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Connections shall be non-reversible. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.3 INSTALLATION

A. Equipotential Ground: Interconnect grounding electrodes to form one, electrically continuous, equipotential grounding electrode system Grounding electrodes to be interconnected include:

1. Ground rods.
2. Lightning protection system.
3. Metal water service pipe.

B. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Verify that final backfill and compaction has been complete before driving ground rods.
2. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
3. Interconnect ground rods with grounding electrode conductors. Use exothermic welds or non-reversing compression-type connectors, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Install in conduit where routed above grade.

1. Aluminum and copper-clad aluminum conductors shall not be used in direct contact with masonry, within 18 inches of the earth, or where subject to corrosive conditions.

D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors or non-reversing compression-type connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

E. Metal Water Service Pipes in direct contact with the earth for 10 feet: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to all metal water service entrances to building including fire protection water service entrance. Connect grounding conductors to metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

H. Separately Derived AC Power Systems: Ground separately-derived ac power system neutrals to grounding electrodes per NFPA 70.

I. Packaged Engine Generator: Solidly ground the packaged engine generator neutral to the normal power source neutral. Do not ground the generator neutral to a separate grounding electrode.

J. Grounding Bus:

1. Install grounding bus in the locations listed below and elsewhere as indicated:

a. Electrical equipment rooms.
b. Telephone equipment rooms.
c. Rooms housing service equipment.

2. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.

K. Equipment Grounding: Provide a permanent and continuous bonding of conductor enclosures, equipment frames, power distribution equipment ground busses, cable trays, metallic raceways, and other non-current carrying metallic parts of the electrical system.

L. Bond together metal building elements not attached to grounded structure; bond to ground.

M. Provide a flexible braid bonding jumper at each set of columns at expansion joints.

N. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with transformers/substations by connecting them to underground cable and grounding electrodes. Use not less than a No. 2 AWG conductor for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.4 TELECOMMUNICATIONS GROUNDING

A. Telecommunications Grounding System: The telecommunications grounding system shall consist of:

1. Telecommunications Main Grounding Busbar (TMGB) located in the main telecommunications room near the telecommunications service entrance. Bond to the main building electrical grounding electrode system via a No. 3/0 AWG copper ground conductor.
2. A Telecommunications Grounding Busbar (TGB) in each telecommunications room, cabinets, etc.
3. A Telecommunications Bonding Backbone (TBB) tying together the TMGB and each TGB.

B. All bonding connections shall be installed at an accessible location for inspection and maintenance.

C. All telecommunications bonding connections shall be of an approved mechanical type connection. Do not use exothermic welds unless specifically indicated on the Drawings.

D. The physical routing shall, in general, follow the same path as the backbone cable system.

E. Bond each TGB directly to the building steel with a No. 6 AWG conductor.

F. Do not use TGB's as a power system ground connection unless specifically noted on the Drawings.

G. All bonding connectors and conductors shall be UL listed for the purpose intended.

H. Mount TMGB and TGB bus to backboard or wall using 2" standoff insulators.

I. Individually bond each piece of non-current carrying metallic equipment in the Telecommunications Room to the TGB.

J. Install continuous cable from the TMGB to the furthest TGB. Bond all TGB's to TBB with bare No. 3/0 AWG copper ground conductor and T-tap grounding hardware.

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"

1. Inspect grounding and bonding system conductors and connections for tightness and proper installation and for compliance with the Drawings and Specifications.
2. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

    a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
    b. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    c. Perform tests, by the fall-of-potential method according to IEEE 81. Instrumentation utilized shall be as defined in Section 12 of IEEE 81 and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that curves flatten in the 62% area of the distance between the item under test and the current electrode.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

    a. Equipment Rated 500 kVA and Less: 10 ohms.
    b. The telecommunications grounding system shall have a maximum resistance of 1 ohm as measured from the TMGB ground to earth ground.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

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 Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; a part of Atkore International.
b. B-Line, by Eaton.
c. GS Metals Corp.
d. Pentair Electrical & Fastening Solutions.
e. Thomas & Betts Corporation.
f. Unistrut; a part of Atkore International.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) B-Line by Eaton.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.3 ROOF MOUNTED CONDUIT AND EQUIPMENT SUPPORTS

A. General: Shop- or field- fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted conduit and equipment.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-Line by Eaton; Dura-Blok.
2. MIRO Industries.
3. Pentair Electrical & Fastening Solutions; Caddy Pyramid.
4. Pipe Pier Support Systems; Pipe Piers.

C. Adjustable Compact Stand: Recycled rubber base unit with integral threaded coupling capable of accepting 3/8-16 threaded rod, or 1-5/8 inch by 1-5/8 inch metal strut and various supporting elements.

D. Multiple-Conduit and Equipment Stand: Assembly of bases, vertical and horizontal members, and conduit supports, for roof installation without membrane penetration.

1. Bases: One or more adjustable compact stand bases.
2. Vertical Members: Two or more protective-coated-steel channels.
3. Horizontal Member: Protective-coated-steel channel.
4. Supports: Standard strut clamps, hangers, and accessories.

2.4 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 6 Section "Rough Carpentry." Plywood sheets shall be free of all voids. Plywood shall have a minimum of two coats of fire-resistant, non-conducting paint applied to all sides of all sheets. Provide flush hardware and supports to mount plywood to wall. The provided hardware shall have sufficient strength to carry all anticipated loads including, but not limited to cabling, cable management and equipment racks.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with:

a. Two-bolt conduit clamps
b. Single-bolt conduit clamps
c. Single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

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.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel:

    a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
    b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
    c. Spring-tension clamps.

6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel support systems attached to substrate.

D. Slotted support systems applications:

1. Indoor dry and damp Locations: Painted Steel
2. Outdoors and interior wet locations: Galvanized Steel
3. Corrosive Environments, including pool equipment rooms: Nonmetallic

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

G. Obtain permission from Architect/Engineer before drilling or cutting structural members.

H. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

I. Install surface-mounted cabinets and panelboards with minimum of four anchors.

J. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

K. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

L. The Contractor shall replace all supports and channels that sag, twist, and/or show signs of not providing proper structural support, to the equipment, it is intended for, as determined by the Owner and Architect/Engineer. All costs associated with replacing supports and steel channels shall be incurred by the Contractor.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 INSTALLATION OF ROOF MOUNTED SUPPORTS

A. Install in accordance with manufacturer's instructions.

B. If gravel top roof, gravel must be removed around and under support.

C. Consult roofing manufacturer for roof membrane compression capacities. If required, a compatible sheet of roofing material (rubber pad) may be required under rooftop support to disperse concentrated loads and add further membrane protection.

D. Utilize properly sized clamps and accessories to suit conduit sizes.

E. Provide vertical steel channel members as required for elevated conduit supports where required for clearances, coordination with other roof mounted systems or derating.

3.5 CONCRETE BASES

A. Provide concrete bases for all floor mounted electrical equipment.

B. Provide concrete bases for all exterior, grade level electrical equipment, and where indicated.

C. Base/Pad Construction:

1. Construct per manufacturer's recommendations for particular equipment, including suggested piers and dowel rods.
2. Interior concrete bases shall have a minimum depth of 4" unless other indicated or recommended by the manufacturer.
3. Exterior concrete bases shall have a minimum depth of 8" unless other indicated or recommended by the manufacturer.
4. Construct concrete bases for primary and secondary power distribution equipment per requirements of the electrical utility, where submitted for its review.

D. Anchor equipment to base per both supports and equipment manufacturer's instructions.

E. Coordinate conduit openings and sleeve locations in base with requirements of equipment to be supported.

3.6 BACKBOARDS

A. A minimum of two walls (or as indicated on drawings) shall be covered with plywood backboards to a minimum 8'-6" above finished floor in all Telecommunication Rooms and similar spaces and as indicated on Drawings.

B. Securely fasten backboard to wall using appropriate hardware and mount at all four corners, minimum. Securely fasten backboard to wall-framing members (studs).

C. Provide adequate backboard space to allow a clean and workable arrangement for telephone and data connections.

3.7 PAINTING

A. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 07 Section, “Penetration Firestopping” for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
2. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings, and for access floor boxes and service poles.
3. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. RNC: Rigid nonmetallic conduit.

H. PVC: Polyvinyl Chloride.

I. HDPE: High Density Polyethylene.

J. RTRC: Reinforced Thermosetting Resin Conduit

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, 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.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube Triangle Century.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. International Metal Hose.
6. Electri-Flex Co
7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
8. LTV Steel Tubular Products Company – Manhattan/CDT/Cole-Flex.
9. Maverick.
10. O-Z Gedney; unit of General Signal.
11. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit, IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel or Aluminum.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, set-screw or compression type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 FIRE ALARM EMT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Tube Triangle Century.

B. EMT conduit with bright red topcoat; Fire Alarm EMT.

C. EMT and Fittings: ANSI C80.3.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe and Plastics Group.
6. Condux International.
7. ElecSys, Inc.
8. Electri-Flex Co.
9. Integral.
10. Kor-Kap.
11. Lamson and Sessions: Carlon Electrical Products.
12. Manhattan/CDT/Cole-Flex.
13. RACO; Division of Hubbell, Inc.
14. Scepter.
15. Spiralduct, Inc./AFC Cable Systems, Inc.
16. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

E. LFNC: UL 1660.

F. HDPE: UL 651, ASTM D 3350, ASTM D 1248 Schedule 40.

G. RTRC: Comply with UL 2515A and NEMA TC 14.

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hoffman.
2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or as required by conditions.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Airey-Thompson Sentinel Lighting: Wiremold Company (The).
b. Thomas & Betts Corporation.
c. Walker Systems, Inc.; Wiremold Company (The).
d. Wiremold Company (The); Electrical Sales Division.
e. Mono-Systems, Inc.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2. Shall be used in corrosive areas.

D. Floor Boxes: Cast metal, fully adjustable, rectangular.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Shall be used in areas exposed to water.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with ANSI/SCTE 77.

1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC", “COMMUNICATIONS” or as indicated for each system service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell: Quazite
b. Armorcast Products Company.
c. Carson Industries LLC.
d. CDR Systems Corporation.
e. NewBasis.
f. Christy Concrete Products.

2.8 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.9 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Plastic. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.10 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Provide raceways in interior and exterior locations in accordance with the “Raceway Application Matrix” included on the drawings.

B. Boxes and Enclosures, Exterior Aboveground: NEMA 250, Type 3R.

C. Boxes, Enclosures, and Handholes:

1. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
2. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

D. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

E. Minimum Raceway Size: 3/4-inch trade size

F. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

G. Do not install aluminum conduits in contact with concrete.

H. Install surface raceways only where indicated on Drawings.

I. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install temporary closures to prevent foreign matter from entering raceways.

F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

J. Support conduit within 12 inches of enclosures to which attached.

K. Raceways Embedded in Slabs:

1. Raceways embedded in slabs shall be limited to above grade concrete decks. Embedded conduit shall be limited to servicing floor boxes and equipment located in open spaces away from accessible walls.
2. Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
3. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
4. Space raceways laterally to prevent voids in concrete.
5. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
6. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
7. Conduits shall run flat. Do not allow conduits to cross.
8. Change from non-metallic raceway to rigid steel before turning up out of the concrete and rising above the floor.

L. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

S. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

U. Communications and Signal Cabling Systems Raceways: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

1. Electrical condulet (LB's) are not permitted.
2. Conduits shall have no more than two 90 degree bends between pull points or pull boxes.
3. Conduits shall contain no continuous sections longer than 150 ft. without a pull point/box.
4. Conduit for fiber cabling shall have a bend radius of at least 10 times the internal diameter.
5. Conduit for copper cabling less than 2" shall have a bend radius of at least 6 times the internal diameter. Conduit for copper cabling 2" and larger shall have a bend radius of at least 10 times the internal diameter.
6. All conduit ends shall have an insulated bushing.

V. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where conduits route through, to, or from a hazardous classified space (Class I or II), provide proper seal offs when exiting or entering the hazardous classified space.
3. Where conduits pass between spaces that are maintained at two different vapor pressures.
4. Where otherwise required by NFPA 70.

W. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

X. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide

expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Flexible Conduit Connections: Comply with NEMA RV3. Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

Z. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals. Provide cover clips to cover space between connecting pieces.

AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

CC. Locate boxes so that cover or plate will not span different building finishes.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set floor boxes level and flush with finished floor surface. Trim non-metallic boxes after installation to fit flush with finished floor surface.

GG. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

HH. Do not route feeders across roof unless approved in writing by Engineer.

II. Provide a pull box (a handhole for outdoor applications) for each conduit run that exceeds 250 feet. Provide two pull boxes (handholes for outdoor applications) for runs that exceed 500 feet.

JJ. Outlet boxes within hazardous locations shall be of the proper class and division as noted in the N.E.C.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 2 Section "Earthwork."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, 42” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop Systems."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.9 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 260533

SECTION 260536 - CABLE TRAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This Section includes stainless-steel cable trays and accessories for telecommunications cable.

C. Related Sections include the following:

1. Division 7 Section under “Through Penetration Firestop Materials" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.

1.2 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable/basket tray.

1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Qualification Data: For testing agency.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.

B. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

C. 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.

D. Comply with NEMA VE 1, "Metal Cable Tray Systems," if cable tray types specified are defined in the standard.

E. Comply with NFPA 70.

1.4 COORDINATION

A. Coordinate layout and installation of cable trays 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.

PART 2 - PRODUCTS

2.1 WIRE BASKET SUPPORT SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-Line Flex-Tray.
2. Cablofil – EZ Tray – Wire-mesh.
3. P-W Industries, Inc. – Wire mesh.
4. Wiremold.
5. Mono-Systems, Inc.

B. Description: Continuous, welded steel wire mesh construction, 2” x 4” longitudinal and lateral spacing orientation respectively, width and load depth as indicated with mounting hardware to secure in place.

C. Material: ASTM A510 high strength steel wires.

D. Finish: Matte White. electrostatic, powder-coat paint finish for tray and all fittings. Exact color to be determined by Architect at time of shop drawing submittal.

E. Inside Width: 24 inches, as indicated.

F. Inside Depth: 4 inches.

G. Inside Radius Fittings: 12 inches.

H. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, inside radius fittings, can grounding straps. All splicing connectors shall be UL listed for bonding or #6 AWG copper bonding conductors shall be installed at all splices of separate cable tray sections.

I. Wall brackets shall be Cablofil CRP Reinforced Bracket**,** or equivalent, sized as required to bear full width of cable tray.

J. Provide lay-in lugs for grounding and bonding cable tray.

K. Provide cable roller kit, Cablofil FAS Roller, or equivalent, including all mounting hardware.

2.2 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRE BASKET SUPPORT SYSTEMS INSTALLATION

A. Install wire basket as indicated; in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.

B. Coordinate wire basket with other electrical work as necessary to properly interface installation of wire basket runway with work of other trades.

C. Provide sufficient space encompassing wire basket to permit access for installing and maintaining cables.

3.3 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions.

B. 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.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing wire basket support system and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform the following electrical test and visual and mechanical inspections:

a. Visually inspect each joint and each ground connection for mechanical continuity.
b. Measure ground resistance of each system of cable tray/basket from the most remote element to the point where connection is made to service disconnect enclosure grounding terminal. Record resistance in ohms.

3. Report results in writing.

3.5 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure cable tray or wire basket support systems is without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 260536

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Identification for raceway.
2. Identification for conductors and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Equipment identification labels.
6. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:

1. Power Circuits: Black letters on an orange field.
2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 3/8 inch.

B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service and Feeders More Than 400 A: Identify with orange self-adhesive vinyl label.

B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.

2. Security System: Blue and yellow.
3. Telecommunication System: Green and yellow.
4. Control Wiring: Green and red.

C. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape and marker tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number as indicated on Drawings. Identify control circuits by control wire number as indicated on shop drawings.

E. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.

F. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to

disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine label mechanically secured.
    b. Outdoor Equipment: Stenciled.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled: If included on project. All items may not be on project.

    a. Panelboards, electrical cabinets, and enclosures.
    b. Access doors and panels for concealed electrical items.
    c. Electrical switchgear and switchboards.
    d. Emergency system boxes and enclosures.
    e. Disconnect switches.
    f. Enclosed circuit breakers.
    g. Motor starters.
    h. Push-button stations.
    i. Power transfer equipment.
    j. Contactors.
    k. Remote-controlled switches, dimmer modules, and control devices.
    l. Power-generating units.
    m. Intercommunication and call system master and staff stations.
    n. Television/audio components, racks, and controls.
    o. Fire-alarm control panel and annunciators.
    p. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
    q. Monitoring and control equipment.
    r. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
    s. Breakers or switches at distribution panels.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location:

1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
2. Conduit Markers: Provide identification for each power conduit containing conductors rated 400A or greater.

C. Apply identification devices to surfaces after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208/120-V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.
    d. Grounded Conductor (Neutral): White.

3. Colors for 480/277-V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Ground Conductor (Neutral): Grey.

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

I. Label information arrangement for 3 lines of text.

1. Line one shall describe the panel or equipment. Line one example: “DP-XX,” RP-XX,” “T-XX,” “EF-XX,” etc.
2. Line two shall describe the first disconnecting means feeding this panel or equipment. Line two example: “Fed from DP-XX,” “Fed from RP-XX,” etc.
3. Line three indicates that location of the disconnecting means as identified in line two. Line three example: “First Floor Elect. Rm #XXX.”
4. Line four shall include “Via T-XX” when panel or equipment is fed from a transformer.

J. Examples:

RP-1A FED FROM DP-1A ELECTRICAL ROOM A100 VIA T-1A	EF-1 FED FROM MCC-1A MECHANICAL ROOM F101	LP-1A LOCATED IN ELECTRICAL ROOM A100

K. Fusible Enclosed Switches and Distribution Equipment: Install self-adhesive vinyl label indicating fuse rating and type on the outside of door on each fused switch.

L. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

M. Degrease and clean surface to receive nameplates.

N. Install nameplate and labels parallel to equipment lines.

O. Secure nameplate to equipment front using screws.

P. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

Q. Identify conduit using field painting where required.

R. Paint red colored band on each fire alarm conduit and junction box.

S. Paint bands 10 feet on center, and 4 inches minimum in width.

END OF SECTION 260553

SECTION 260573 - OVERCURRENT DEVICE COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018, Annex D prepared by the electrical equipment manufacturer.

C. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 -National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition.

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination, and arc flash hazard analysis studies shall be summarized in a final report. Report shall be provided on electronic media. All literature shall be combined in one document and shall be properly bookmarked with all applicable sections.

B. The report shall include the following sections:

1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.

5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Details of the incident energy and flash protection boundary calculations.
7. Recommendations for system improvements, where needed.
8. One-line diagram.

C. Arc flash labels shall be provided in full size representation in PDF format and submitted with the study.

D. The report shall be signed and sealed by the Professional Engineer supervising the study.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies and registered in the state where the project is located.

D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER SOFTWARE PROGRAMS

A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:

1. EDSA Micro Corporation.
2. SKM Systems Analysis, Inc.
3. ESA Inc.
4. CGI CYME.
5. Operation Technology, Inc.

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Tabulations of calculated quantities
6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility’s supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings

2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. For emergency and standby distribution paths, provide selective coordination tables to demonstrate tested upstream/downstream breaker pairs selectively coordinate across the full range of over currents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associate with those fault currents.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal./cm2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

    a. Voltage
    b. Calculated fault current magnitude and angle
    c. Fault point X/R ratio
    d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

    a. Voltage
    b. Calculated symmetrical fault current magnitude and angle
    c. Fault point X/R ratio
    d. Calculated asymmetrical fault currents

        1) Based on fault point X/R ratio
        2) Based on calculated symmetrical value multiplied by 1.6
        3) Based on calculated symmetrical value multiplied by 2.7

    e. Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

    a. Voltage
    b. Calculated symmetrical fault current magnitude and angle
    c. Fault point X/R ratio
    d. No AC Decrement (NACD) Ratio
    e. Equivalent impedance
    f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
    g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:

    a. Current transformer ratio
    b. Current setting
    c. Time setting
    d. Instantaneous setting
    e. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:

    a. Adjustable pickups and time delays (long time, short time, ground)
    b. Adjustable time-current characteristic
    c. Adjustable instantaneous pickup
    d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify design engineer in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label for equipment where arc incident energy is calculated shall include the following, at a minimum:

1. Location designation
2. Nominal system voltage
3. Arc flash boundary
4. Incident energy
5. Working distance
6. Engineering report number, revision number and issue date.

D. The label for equipment where arc incident energy is not calculated shall include the following, at a minimum:

1. Location designation
2. Nominal system voltage
3. Arc flash boundary from NFPA 70E 2018 Table 130.7(C) 15(a)
4. Arc flash PPE category from NFPA 70E 2018 Table 130.7(C) 15(a)
5. Engineering report number, revision number and issue date.

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and 208 volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

G. Labels shall be field installed by the contractor.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Time controllers.
2. Outdoor and indoor photoelectric control.
3. Occupancy sensors.
4. Lighting contactors.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements”.
2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.
3. Division 26 Section "Lighting Control Systems" for programmable lighting systems.

1.3 REFERENCES

A. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.

B. IEEE C136.10: Standard for Roadway Lighting Equipment Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing.

C. NEMA ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC Part 8: Disconnect Devices for Use in Industrial Control Equipment.

D. NFPA 70: National Electrical Code.

E. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

F. UL 486B: Wire Connectors for Use with Aluminum Conductors.

G. UL 773: Plug-in, Locking Photocontrols for Use with Area Lighting.

H. UL 773A: Nonindustrial Photoelectric Switches for Lighting Control.

I. UL 917: Clock Operated Switches.

J. UL 1449: Surge Protective Devices.

K. UL 1598: Luminaires.

L. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.4 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

C. ULTRASONIC: Active emission of at least 35 kHz sound waves, using Doppler reflectance to detect motion.

D. MICROPHONIC: Passive reception to listen for continued occupancy, with circuitry to filter out white noise.

E. MULTI-Tech: Using PIR and ultrasonic or microphonic technologies in one sensor.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated including physical data and electrical performance.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Lighting plan showing location, orientation, and coverage area of each sensor.
2. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:

1. Description of operation and servicing procedures.
2. List of major components.
3. Recommended spare parts.
4. Programming instructions and system operation procedures.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate interface of lighting control devices with temperature controls specified in Division 23.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 26 Section “Electrical General Requirements”.

B. Store and protect products under provisions of Division 26 Section “Electrical General Requirements”.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.2 TIME CONTROLLERS

A. Manufacturers:

1. Intermatic, Inc.
2. TORK.

B. General

1. Provide NEMA Type 1-general purpose steel enclosure with corrosion-resistant primer and baked enamel finish in manufacturer's standard color.
2. Provide enclosure suitable for surface mounting with hinged front; padlock hasp; and side, bottom, and back knockouts for conduit connections.
3. Provide heavy-duty pressure terminals suitable for wire sizes up to no. 8 AWG.

C. Digital Time Controller: Electronic, solid-state programmable units with alphanumeric display complying with UL 917.

1. Contact Configuration: SPDT.
2. Contact Rating Normally Open: (20-A inductive or resistive, 120-277-V ac, 20-A ballast load, 120-277 V ac.) (10-A inductive or resistive, 120-277-V ac, 10-A ballast load, 120 277 V ac.)
3. Contact Rating Normally Closed: 10-A inductive or resistive, 120-277-V ac, 10-A ballast load, 120-277 V ac.
4. Input Voltage:120 volts.
5. Programs: 2 channels.

    a. For each channel, 7 day or full year load control, minimum 1,000 on/off operations with one-minute programming resolution; minimum 99 holiday event scheduling; automatic adjustment for daylight savings (with disable); automatic leap year compensation; manual override ON and OFF to the next scheduled event; LCD display.

6. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program on selected channels.
7. Astronomical Time: Provide astronomic feature adjustable from 10° to 60° Northern and Southern latitudes with 1-99 minute adjustable offset from sunrise to sunset for all channels.
8. Battery Backup: Field replaceable lithium battery with minimum 8 year life for schedules and time clock.
9. Contact Configuration: SPST. Coordinate with lighting circuiting.
10. Contact Rating: 40 amperes tungsten, 120-277 V ac.
11. Input Voltage:120 volts.
12. Program: 24 hour dial, which can perform a minimum of 10 On/Off operations within a 24-hour period. Provide a minimum of 1 hour setting for ON or OFF operations and maximum ON time of 20 hours.

    a. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program.

13. Accessories:

a. Provide time control with day omitting feature which permits override of time control for manually selected days over a seven day period.
b. Provide wound-spring reserve carryover mechanism to keep time during power failures up to 16 hours. Carryover mechanism shall automatically rewind upon power restoration.

2.3 OUTDOOR PHOTOELECTRIC CONTROL

A. Manufacturers:

1. Intermatic, Inc.
2. Square D.
3. TORK.

B. General

1. Provide fully-gasketed, weathertight enclosure constructed of die cast zinc, with one-half inch conduit nipple for mounting purposes, and with positioning lug to permit full 360-degree adjustable orientation of photocell.
2. Provide hermetically-sealed, one-inch-diameter, cadmium sulphide photoelectric cell with manual, light level selector.
3. Provide photoelectric control suitable for an operating temperature range of minus 40 degrees F to plus 140 degrees F.

C. Description: Solid state, with SPST dry contacts rated for 2000 W tungsten or 1800 VA ballasted load, to operate connected load, relay, contactor coils, or microprocessor input, and complying with UL 773A.

1. Light-Level Monitoring Range: Adjustable turn-on range of 1 to 5 footcandle and adjustable turn-off range of 3 to 15 footcandle, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: Adjustable delay up to two minutes to prevent false operation.
3. Contacts: Normally closed, fail on.
4. Electrical: Provide photocell with operating voltage rated to switch the load directly unless otherwise indicated.
5. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
6. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.
7. Provide hermatically-sealed, one inch diameter, cadmium sulphide photoelectric cell with manual, 2 to 50 footcandle, light level selector.

2.4 INDOOR PHOTOELECTRIC CONTROL

A. Manufacturers:

1. Wattstopper LS-101.
2. Sensorswitch CM-PC.

B. Photoelectric Sensor: Solid-state, light-level sensor unit utilizing an internal photoconductive cell to detect changes in lighting levels and capable of controlling any lighting source.

1. Housing: White, thermoplastic, tamper resistant, ceiling mount.
2. Sensor shall operate on 24V DC power through a control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
3. Light-Level Monitoring Range: 50 to 1000 footcandle, with an adjustment for turn-on and turn-off levels within that range.
4. Deadband: Adjustable range of 10 to 300%.
5. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
6. Indicator: Two LEDs to indicate the beginning of on and off cycles.
7. Manual override function.
8. Provide indoor photoelectric switches and control units from single manufacturer.
9. Provide indoor photoelectric switches from same manufacturer as occupancy sensors.

C. Indoor Photoelectric Sensor Control Units:

1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.

    a. Control units shall be provided as required to power indoor photoelectric sensor, control lighting loads and provide a minimum of one auxiliary contact.
    b. Sensor control units shall mount external to 4" sq junction box in the ceiling space. Wiring between control unit and photoelectric switch shall be plenum rated.
    c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.
    d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.
    e. It is acceptable to provide controls and auxiliary contacts as required integral to the sensor, provided all required contacts are provided.
    f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.5 OCCUPANCY SENSORS

A. General

1. Coordinate occupancy sensor locations, coverages and required quantities with manufacturer's recommendations. Coverage areas indicated on the Drawings are for minor motion (6 to 8 inches of hand movement). Provide additional occupancy sensors and control units as required to achieve complete minor motion coverage of the space indicated.
2. Adjust occupancy sensors and test that complete minor motion coverage is obtained in accordance with Part 3. Provide written confirmation of testing to owner, architect and engineer.
3. Provide occupancy sensors with a bypass switch to override the "ON" function in the event of sensor failure.
4. Provide occupancy sensors with an LED indicator indicating when motion is being detected during testing and normal operation of the sensor.
5. Provide occupancy sensors and occupancy sensor control units from single manufacturer.

B. Wall Switch Passive Infrared Occupancy Sensor

1. Manufacturers:

a. Perfect Sense – PS-PWS
b. Wattstopper PW-100.
c. Hubbell Building Automation SOM 101.
d. Greengate OSW-P-0451-W.
e. Sensorswitch WSD.
f. Philips LRS2210.
g. Leviton ODS10-IDW.

2. Description: Wall mounted, 180° coverage, passive infrared sensing occupancy sensor.

a. Electrical Characteristics: Capable of switching up to 800W fluorescent or incandescent lighting loads at 120V and 1200 watts fluorescent loads at 277V.
b. Functions: Automatic ON/Automatic OFF, or Manual ON/Automatic OFF operation, field selectable. Integral manual override pushbutton switch.
c. Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 30 minutes. Ambient light sensing if specified shall be adjustable from 20 footcandle to 300 footcandle, with override.
d. Ambient Light Sensor where indicated: Integral ambient light sensor to switch off lights when sufficient daylight is present.
e. Device Body: White plastic with momentary on/off override pushbutton designed to mount in a standard switch box with “decora” style switch plate.

C. 360° Ceiling Mounted Dual Technology Occupancy Sensor

1. Manufacturers:

a. Perfect Sense CDS.
b. Wattstopper DT 300
c. Hubbell Building Automation “OMNI-DT” Series.
d. Greengate OMC-DT-2000-R.
e. Sensorswitch CM-PDT-R.
f. Philips LRM2255.
g. Leviton OSC10-M0W.

2. Description: Ceiling mounted, 360° coverage, multi-tech sensing occupancy sensor.

a. Housing: White, thermoplastic, tamper resistant ceiling mount.
b. Functions: Automatic ON must sense motion from both ultrasonic and infrared sensing elements. Either technology shall maintain ON, with adjustable time delays.
c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.
d. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
e. Manual override function.

D. 110° Wall Mounted Dual Technology Occupancy Sensor

1. Manufacturers:

a. Perfect Sense DTC.

b. Wattstopper DT-200
c. Hubbell Building Automation “LO-DT” Series.
d. Sensorswitch WV-PDT-R/WV-BR.
e. Philips LRM2265.
f. Leviton OSW12-M0W.

2. Description: Wall mounted, 110° coverage, multi-tech occupancy sensor.

a. Housing: White, thermoplastic, tamper resistant with swivel bracket for wall or ceiling mounting.
b. Functions: Automatic ON must sense motion from both sensing elements. Either technology shall maintain ON, with adjustable time delays.
c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 15 minutes.
d. Sensor Orientation: Orient sensor in room such that sensor will not detect motion through open door which could cause false activation.
e. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
f. Manual override function.

E. 360° Ceiling Mounted Ultrasonic Occupancy Sensors

1. Manufacturers:

a. Perfect Sense WDS.
b. Wattstopper “WT” Series.
c. Hubbell Building Automation “OMNI-US” Series.
d. Greengate OPC-U-2000.
e. Sensorswitch CM MPT-10.
f. Philips LRM2255.
g. Leviton OSC20-U0W.

2. Description: Ceiling mounted, 360° coverage, ultrasonic or microphonics sensing occupancy sensor.

a. Housing: White, thermoplastic, tamper resistant.
b. Adjustments: Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 15 minutes.
c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
d. Manual override function.

F. 360° Ceiling Mounted Passive Infrared Occupancy Sensor.

1. Manufacturers:

a. Perfect Sense CPS.
b. Wattstopper CI-200.
c. Hubbell Building Automation OMNI-IR.
d. Greengate OMC-P-04500-R.

e. Sensorswitch CM-9.
f. Philips LRM2250.
g. Leviton OSC04-I0W.

2. Description: Ceiling mounted, 360° coverage, infrared sensing occupancy sensor.

a. Housing: White, thermoplastic, tamper resistant ceiling mount.
b. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.
c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
d. Manual override function.

G. Occupancy Sensor Control Units:

1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.

a. Control units shall be provided as required to power ceiling mounted occupancy sensors, control lighting loads and provide a minimum of one auxiliary contact.
b. Occupancy sensor control units shall mount external to 4" sq junction box in the ceiling space. Wiring between control unit and occupancy sensor shall be plenum rated.
c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.
d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.
e. It is acceptable to provide controls and auxiliary contacts as required integral to the ceiling sensor, provided all required contacts are provided.
f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.6 LIGHTING CONTACTORS

A. Manufacturers:

1. Cutler-Hammer; Eaton Corporation.
2. Square D Co.
3. General Electric.
4. Siemens.
5. Square D Co; class 8903.

B. Contactor

1. Electrically-operated mechanically-held contactor, per NEMA ICS2, with 120 volt, 60 hertz coil and 240 volt, 60 hertz, 20 ampere contacts.
2. Provide contacts to be 100 percent, continuously rated for all types of ballast and tungsten lighting and resistance loads without the need for in-rush current derating.
3. Provide NEMA type 1 enclosure unless otherwise indicated.
4. Provide solderless pressure wire terminals.

5. Provide corrosion-resistant primer treatment with light gray baked acrylic enamel finish.
6. Provide the following control and indicating devices:

    a. Auxiliary contacts: One field convertible.
    b. Auxiliary relay to convert maintained-contact type control circuit to momentary-contact type control circuit necessary for contactor control.
    c. Hand-off-auto selector switch, of the heavy-duty “oil-tight”, maintained-contact type, mounted on the front cover with legend plate.
    d. Control transformer with primary voltage as indicated and 120-volt, single phase, 60 hertz secondary including fuse and fuseholder.
    e. Green pilot light to indicate “power on” condition. Mount on front cover with legend plate.

PART 3 - EXECUTION

3.1 LIGHTING CONTACTOR INSTALLATION

A. Install lighting contactors as indicated on plan. Install at accessible locations. Switch controls where provided shall be no higher than 54” or lower than 48”.

B. Demonstrate proper operation of all lighting control functions to the Owner and Engineer.

3.2 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION

A. Mount photocell on roof or parapet to ½” GRS conduit, supported to building structure below. Coordinate roof penetration with roofing contractor.

B. Install photoelectric control oriented in the northeast direction and not within any potential shadows.

C. Adjust photocell sensitivity and delay to meet owner’s requirements. Multiple adjustments may be required, as needed.

3.3 TIME CONTROLLER INSTALLATION

A. Install time controller, near contactor control equipment or as indicated on plan. Install at accessible location.

B. Program time controller as directed by the owner. Train owner in time clock programming.

3.4 OCCUPANCY SENSOR INSTALLATION

A. Install wall mounted occupancy sensors as noted on plan. Arrange occupancy sensors with adjacent switch devices so that device plates line-up and are equally spaced.

B. Install ceiling mounted sensors at approximate locations as indicated on plan. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.

C. Locate sensors such that motion through open doors will not falsely activate sensors.

D. Do not locate ultrasonic sensors within six feet of supply air diffusers.

E. Locate infrared sensors to avoid obstructions.

F. Provide the services of a manufacturer's representative for commissioning of occupancy sensor installation. This shall include consultation on layout and location prior to installing sensors, testing of each sensor for compliance with Contract Documents and field adjustment and fine tuning after installation is complete. Provide written confirmation of testing to the Owner, Architect and Engineer.

G. Field adjustments shall take place in the presence of the owner and the engineer. This shall include owner training on adjustment techniques for the occupancy sensors.

3.5 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Conductors and Cables".

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. 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.

3.6 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

B. Label time switches and contactors with a unique designation.

3.7 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 260923

SECTION 260943 - LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the design and installation programmable automatic lighting controls with all input and control devices necessary to meet the performance indicated on the contract drawings and this specification

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multi-pole contactors.

2. Division 26 Section “LED Interior Lighting” for luminaire specifications and accessories.

1.3 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. Lon Works: A control network technology platform for designing and implementing interoperable control devices and networks.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

D. RS-485: A serial network protocol, like RS-232, complying with TIA/EIA-485-A.

1.4 SUBMITTALS

A. Product Data: Indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature for all sensors, relays, dimming modules, control stations and other devices necessary for complete operation of the system

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.

1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements for all system components requiring field installation.
2. Riser Diagram: Show interconnection between all system components.

    a. Identify complete data communication backbone and interconnection between sensors, relays, dimming modules control stations and other components.
    b. Identify typical room/area type configurations.
    c. Indicate interconnections with emergency egress lighting relays and transfer devices required.

3. Information Technology (IT) connection: Provide information pertaining to interconnection with facility IT networking equipment and third-party systems.
4. Other Diagrams and Operational Descriptions – as needed to indicate system operation or interaction with other system(s).
5. Contractor startup and commissioning worksheet.

C. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

D. Submit qualifications of commissioning agent and draft functional test plans for review and approval.

E. Field quality-control test reports and commissioning reports at project closeout.

F. Software licenses and upgrades required by and installed for operation and programming of digital devices.

G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals. Include the following:

1. Software manuals.
2. Operation of adjustable zone controls.
3. Description of operation and servicing procedures.
4. List of major components and recommended parts.
5. System operation and integration instructions.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer with total responsibility for compatibility of lighting control system components specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

E. Listed as qualified under Design Lights Consortium (DLC) Networked Lighting Control System Specification V2.0.

F. System luminaires and controls are certified by manufacturer to have been designed, manufactured and tested for interoperability.

G. Comply with ASHRAE 90.1 - 2013

1.6 COORDINATION

A. Coordinate lighting control components specified in this Section and with systems and components specified in other Sections to form an integrated interconnection of compatible components.

B. Match components and interconnections for optimum performance of lighting control functions.

C. Provide open protocol interface for interoperability with building automation system including status of each occupancy/vacancy sensor, control station, dimming module, relay, time schedule, display graphics and status of lighting controls by zone.

D. Coordinate lighting controls with devices specified in Division 26 Section “Lighting Control Devices”.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.8 SYSTEM COMMISSIONING

A. Provide the services of a third party, independent agent to perform functional testing and verification of the lighting control system to comply with the requirements of ASHRAE 90.1 – 2013.

B. Perform functional testing of all lighting control system operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acuity nLight Air
2. Lutron Vive
3. WaveLinx – Eaton

2.2 SYSTEM PERFORMANCE REQUIREMENTS

A. System Architecture

1. System shall have an architecture that is based upon three main concepts: (a) networkable intelligent lighting control devices, (b) standalone lighting control zones using distributed intelligence, (c) system backbone for remote, time based and global operation between control zones.

a. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible to minimize overall device count of system.
b. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher-level system backbone; this capability is referred to as “distributed intelligence.”
c. System must be capable of interfacing directly with networked luminaires such that low voltage network cabling is used to interconnect networked luminaires with control components such as sensors, switches and system backbone.

2. The system shall provide individually addressable switching and dimming control of the following: networked luminaires, control zones to include multiple switch legs or circuits, and relay and dimming outputs from centralized panels to provide design flexibility appropriate with sequence of operations required in each project area or typical space type. A single platform shall be used for both indoor and outdoor lighting controls.
3. Lighting control zones shall be networked with a higher-level system backbone to provide time-based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software.
4. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality later.
5. System shall be capable of "out of box" sequence of operation for each control zone. Standard sequence is:

    a. All switches control all fixtures in a zone
    b. All occupancy sensors automatically control all fixtures in the control zone with a default timeout.

B. Wired Networked Control Zone Characteristics

1. All networked devices connected with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g., software application, handheld remote, pushbutton). The "out of box" default sequence of operation is intended to provide typical sequence of operation to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.
2. System shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.
3. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:

    a. Low-Voltage power sensing: These devices shall automatically provide 100% light level upon detection of loss of power sensed via the low voltage network cable connection.
    b. UL924 Listed Line-Voltage power sensing: These devices shall be listed as emergency relays under the UL924 standard and shall automatically close the load control relay(s) and provide 100% light output upon detection of loss of power sensed via line voltage connections.
    c. Emergency egress devices shall be provided, and UL labeled by the lighting control manufacturer.

C. System Integration Capabilities

1. The system shall be capable of interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.

    a. Systems utilizing a third-party converter or systems that require a dedicated server to achieve integration are not acceptable.

2.3 SYSTEM SOFTWARE INTERFACES

A. Management Interface

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. All system software updates must be available for automatic download and installation via the internet.

B. Historical Database and Analytics Interface

1. System shall provide a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall optionally upload that data to a cloud-based server.

C. Visualization Interfaces

1. System shall provide an optional web-based visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.

D. Portable Programming Interface for Standalone Control Zones

1. Portable handheld application interface for standalone control zones shall be provided for systems that allows configuration of lighting control settings.
2. Programming capabilities through the application shall include, but not be limited to, the following:

    a. Switch, occupancy and photo sensor group configuration
    b. Manual/automatic on modes
    c. Turn-on dim level
    d. Occupancy sensor time delays
    e. Dual technology occupancy sensors sensitivity
    f. Photo-sensor calibration adjustment and auto-setpoint
    g. Trim level settings

2.4 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller

1. System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. System Controller shall perform the following functions:

    a. Facilitation of global network communication between different areas and control zones.
    b. Time-based control of downstream wired and wireless network devices.
    c. Linking into an Ethernet network.
    d. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
    e. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.

3. System Controller shall not require a dedicated PC or a dedicated cloud connection.
4. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
5. Device shall have a standard and astronomical internal time clock.
6. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 Wired connection.
7. System Controller shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.

    a. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the Expansion I/O modules.
    b. BACnet/MSTP shall support 9600 to 115200 baud.
    c. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
    d. System controller must support BACnet/IP Broadcast Management Device (BBMD) and Foreign Device Registration (FDR).

2.5 WIRED NETWORKED DEVICES

A. Wired Networked Wall Switches, Dimmers, Scene Controllers

1. Wall switches & dimmers shall support the following device options:

    a. Number of control zones: 1, 2 or 4. Gang multiple switches where more than 4 control zones are required in a single location under a single faceplate.
    b. Control Types Supported: On/Off or On/Off/Dimming

2. Scene controllers shall support the following device options:

    a. Number of scenes: 1, 2 or 4
    b. Control Types Supported:

        1) On/Off or On/Off/Dimming
        2) Preset Level Scene Type
        3) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene
        4) Selecting a lighting profile to be run by the system’s upstream controller to implement a selected lighting profile across multiple zones

3. Match color specified in Division 26 Section "Wiring Devices."
4. Integral green LED pilot light to indicate when circuit is on.
5. Internal white LED locator light to illuminate when circuit is off.
6. Networked switch stations shall have backlit buttons.
7. Wall Plates:

    a. Single and multi-gang plates as specified in Division 26 Section "Wiring Devices."
    b. Where multiple switches and/or dimmers are adjacent to each other, install a single cover plate. Provide separate boxes or barriers as required for the application.

c. Provide cover plates that are identical in material and dimension to standard single and double gang switch plates.
d. Verify back box requirements for multiple control points with manufacturer.

8. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

B. Wired Networked Graphic Wall Stations

1. Device shall have a full color touch screen.
2. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
3. Graphic wall stations shall support the following device options:

a. Number of control zones: Minimum of 16
b. Number of scenes: Minimum of 16
c. Optional password protection for setup screens.

C. Wired Networked Auxiliary Input / Output (I/O) Devices

1. Auxiliary Input/output Devices shall be specified as an input or output device with the following options:

a. Contact closure input: Programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, ramp light level up or down, or toggle lights on/off.
b. 0-10V analog input: Programmable to function as a daylight sensor.
c. RS-232/RS-485 digital input: Supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
d. 0-10V dimming control output, capable of sinking a minimum of 20mA of current programmable to support all standard sequence of operations supported by system.

D. Wired Networked Occupancy and Photosensors

1. Sensors shall utilize passive infrared (PIR) or passive dual technology (PDT) to detect both major and minor motion as defined by NEMA WD-7 standard.
2. Sensing technologies that are acoustically passive, meaning they do not transmit sounds waves of any frequency do not require additional commissioning. Ultrasonic or Microwave based sensing technologies may require commissioning due to the active nature of their technology, if factory required.
3. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device.
4. Sensor mounting type shall match project design requirements as shown on plans.

a. Sensors shall have optional features for photosensor/daylight override, dimming control, and low temperature/high humidity operation.

5. The system shall support the following types of photocell-based control:

a. On/Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. A time delay or adaptive setpoint adjustable behavior may be used to prevent the system from exhibiting nuisance on/off switching.
b. Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

E. Wired Networked Wall Switch Sensors

1. Wall switches sensors shall support the following device options:

a. User Input Control Types Supported: On/Off or On/Off/Dimming
b. Occupancy Sensing Technology: PIR only or Dual Tech
c. Daylight Sensing Option: Inhibit Photosensor

F. Wired Networked Embedded Sensors

1. Embedded sensors shall support the following device options:

a. Occupancy Sensing technology: PIR only or Dual Tech
b. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor

G. Distributed System Power, Switching and Dimming Controls

1. Devices shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
2. Device programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
3. Device shall be plenum rated.
4. Devices shall be UL Listed for load and load type as specified on the plans.

H. Wired Networked Luminaires

1. Networked luminaire shall have a factory installed mechanically integrated control device and carry a UL Listing as required.
2. Networked LED luminaire shall provide low voltage power to other networked control devices.
3. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by automatically varying the dimming control signal to account for lumen depreciation.
4. System shall be able to provide control of network luminaire intensity, in addition to correlated color temperature of specific LED luminaires.
5. Controls manufacturer is responsible for primary troubleshooting and tech support of complete fixture.

2.6 CONDUCTORS AND CABLES

A. General: All conductors and cables shall comply with the requirements of Division 26 Section "Conductors and Cables." Where cable is permitted to be installed exposed in ceiling space, provide plenum rated cable.

B. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG.

C. Classes 2 and 3 Control Cables: Multi-conductor cable with copper conductors not smaller than No. 22 AWG.

D. Class 1 Control Cables: Multi-conductor cable with copper conductors not smaller than No. 18 AWG.

E. Digital and Multiplexed Signal Cables: As required by system manufacturer. Provide plenum rated cables where installed exposed in ceiling space.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. The lighting control system shall be installed and connected as shown on the plans and as directed by the manufacturer.

B. Comply with NECA 1.

C. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Comply with Division 26 Sections "Conductors and Cables" and “Raceways and Boxes”.

D. Where cables are installed in finished areas with exposed construction, conceal cables from view. Route at top of structural systems and conceal on top of structural members where possible. Where cable is exposed to view, provide raceway. As an alternative to raceway, provide cable that is factory colored to match exposed ceiling. Submit sample to Architect for approval.

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

F. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

G. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

H. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes as per manufacturers’ recommendations.

I. Identify components and power and control wiring according to Division26 Section "Electrical Identification."

J. Label each relay with a unique designation.

3.2 INSTALLATION REQUIREMENTS

A. Review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.

B. Install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals, plans and specifications.

C. Coordination with Owner's IT Network Infrastructure to secure all required network connections to the owner's IT network infrastructure. Provide the owner's representative with all network infrastructure requirements of the networked lighting control system. Provide the manufacturer's representative with all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.

D. Verify integration and interoperability scope with the Mechanical Contractor prior to submittal phase and provide all necessary schedules to the Lighting Control manufacturer.

3.3 SYSTEM STARTUP

A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed by an authorized representative of the manufacturer.

1. Low voltage network cable testing shall be performed prior to system startup at the discretion of the manufacturer.

B. System start-up and programming shall include:

1. Verifying operational communication to all system devices.
2. Programming the network devices into functional control zones to meet the required sequence of operation.
3. Programming and verifying all sequence of operations.
4. Customization of owner's software interfaces and applications.

C. Initial start-up and programming are to occur on-site. Additional programming may occur on-site or remotely over the Internet as necessary.

3.4 DOCUMENTATION

A. Submit software database file with desired device labels and notes completed.

B. Document the installed location of all networked devices, including networked luminaires. Provide as-built plan drawing showing device addresses corresponding to locations of installed equipment.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components and equipment installation, including connections and assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by Architect.

3.6 SYSTEM COMMISSIONING

A. Facilitate the functional testing and verification of the lighting control system by an independent, third party commissioning agent.

B. Perform commissioning in the presence of the Owner’s representative.

C. Submit functional test plan checklist signed by the commissioning agent.

3.7 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting programming functions and other system parameters and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to program, adjust, operate, and maintain lighting controls.

B. Demonstration shall be done only after initial system start-up setup has occurred and system is functioning properly.

C. Demonstration shall consist of a four-hour minimum session.

3.10 MANUFACTURER SUPPORT

A. Manufacturer telephone support shall be available at no cost to the Owner during the warranty period and shall include the following:

1. Assistance in solving programming or other application issues pertaining to the control equipment.
2. The manufacturer shall provide a toll-free number for direct technical support available 7 days a week, 24 hours a day.
3. A factory authorized technician shall be located within a 100-mile radius of the project site.

END OF SECTION 260943

SECTION 260999 - ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements.”
2. Division 26 Section “Conductors and Cables.”
3. Division 26 Section “Grounding and Bonding.”
4. Division 26 Section “Packaged Engine Generators.”
5. Division 26 Section “Enclosed Switches.”
6. Division 26 Section “Transfer Switch.”
7. Division 26 Section “Enclosed Controllers.”
8. Division 26 Section “Surge Protective Devices”
9. Division 26 Section “Switchboards.”
10. Division 26 Section “Panelboards.”
11. Division 26 Section “Fuses.”

1.2 SECTION INCLUDES

A. Engage the services of a recognized corporately independent N.E.T.A. certified testing firm to perform inspections and tests as specified herein.

B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. It is the intent of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design Specifications.

D. The test and inspections shall determine suitability for energization.

E. Equipment to be tested and inspected shall be the equipment shown on the one line diagram and schedules as required by part three of each individual Specification Section. In addition, all equipment that is part of an emergency distribution system shall be tested.

1.3 REFERENCES

A. All inspections and tests shall be in accordance with the latest version of the following codes and standards except as provided otherwise herein.

1. National Electrical Manufacturer's Association - NEMA
2. American Society for Testing and Materials - ASTM
3. Institute of Electrical and Electronic Engineers - IEEE
4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-2017
5. InterNational Electrical Testing Association - NETA Maintenance Testing Specifications-MTS-2015
6. American National Standards Institute - ANSI C2: National Electrical Safety Code
7. State and Local Codes and Ordinances
8. Insulated Cable Engineers Association - ICEA
9. Association of Edison Illuminating Companies - AEIC
10. Occupational Safety and Health Administration
11. National Fire Protection Association - NFPA

    a. ANSI/NFPA 70: National Electrical Code
    b. ANSI/NFPA 70B: Electrical Equipment Maintenance
    c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
    d. ANSI/NFPA 101: Life Safety Code

1.4 QUALIFICATIONS

A. The testing firm shall be a corporately independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person and at least 50% of the on site crew shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies in Electrical Power Distribution System Testing.

D. The testing firm shall only utilize technicians who are regularly employed by the firm on a full-time basis for testing services.

E. The terms used here within such as Test Agency, Test Contractor, Testing Laboratory, or Contractor Test Company, shall be construed to mean the testing organization.

F. Acceptable Testing Firms:

1. Northern Electrical Testing; Phone (248) 689-8980.
2. Utilities Instrumentation Services; Phone (734) 424-1200.
3. High Voltage Maintenance Corporation; Phone (248) 305-5596.
4. Powertech Services, Inc.; Phone (810) 720-2280.
5. Power Plus Engineering, Inc.; Phone (800) 765-3120.
6. Premier Power Maintenance, Inc.; (517) 230-6629

1.5 PERFORMANCE REQUIREMENTS

A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.

B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

C. The testing firm shall notify the Owner's Representative prior to commencement of any testing.

D. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Engineer. The Electrical Contractor shall correct all defects.

E. The testing organization shall maintain a written record of all tests and shall assemble and certify a final test report.

F. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:

    a. Occupational Safety and Health Act.
    b. Accident Prevention Manual for Industrial Operations, National Safety Council.
    c. Applicable state and local safety operating procedures.
    d. NETA Safety/Accident Prevention Program.
    e. Owner's safety practices.
    f. National Fire Protection Association - NFPA 70E.
    g. American National Standards for Personnel Protection.

2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.6 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration

1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Instruments shall be calibrated in accordance with the following frequency schedule:

a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
b. Laboratory instruments: 12 months
c. Leased specialty equipment: 12 months (Where accuracy is guaranteed by Lessor)

4. Dated calibration labels shall be visible on all test equipment.
5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.
7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

B. Field Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:

a. Maintained in good visual and mechanical condition.
b. Maintained in safe, operating condition.

C. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.7 TEST REPORTS

A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:

1. A list of visual and mechanical inspections required by Division 26 Specification Sections in a checklist or similar format.
2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.
3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
4. Record of infrared scan and photos showing potential problem locations.
5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.

B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 THERMOGRAPHIC SURVEY

A. Visual and Mechanical Inspection

1. Remove all necessary covers prior to scanning.
2. Inspect for physical, electrical, and mechanical condition.

B. Equipment to be Scanned

1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.

C. Provide report indicating the following:

1. Problem area (location of "hot spot").
2. Temperature rise between "hot spot" and normal or reference area.
3. Cause of heat rise.
4. Phase unbalance, if present.
5. Areas scanned.

D. Test Parameters

1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.

E. Test Results

1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:

a. Temperature gradients of 37°F to 44.6°F indicate possible deficiency and warrant investigation.
b. Temperature gradients of 44.6°f to 59°F indicate deficiency; repair as time permits.
c. Temperature gradients of 61°F and above indicate major deficiency; repair immediately.

END OF SECTION 260999

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. AFCI: Arc-fault circuit interrupter.

E. RFI: Radio-frequency interference.

F. RMS: Root mean square.

G. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Related Submittals:

1. Provide overcurrent device coordination study to demonstrate proper overcurrent device ratings, adjustments, and settings.

C. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of panelboards and overcurrent protective devices.
d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

D. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

D. 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.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 EXTRA MATERIALS

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. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a. Eaton Corporation; Cutler-Hammer Products.
b. GE by ABB.
c. Siemens Industries, Inc.
d. Square D.

2.2 MANUFACTURED UNITS

A. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.

1. Cabinet Front: Flush or surface cabinet as noted on the Drawings.

a. Eaton LTDD (Piano hinge trim)
b. GE – FGB (front hinge to box).
c. Square D – Continuous piano hinge trim.
d. Siemens – Figure 4 hinge to box w/piano hinge.

2. Finishes:

a. Panels and Trim: Steel and galvanized steel factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

3. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

B. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus Configured Terminators: Compression type.

D. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

E. Surge Protective Devices: Where indicated, provide manufactured units with direct bus connected type as specified in Division 26 Section "Surge Protective Devices."

1. Provide Surge Protective Device for all Distribution and Branch Circuit Panelboards that are part of the Emergency Distribution System.

2. Provide Surge Protective Devices elsewhere where indicated on the drawings.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

C. Main Overcurrent Protective Devices: Circuit breaker or as indicated.

D. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Main bus bars, neutral and ground, shall be sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.

a. Circuit Breakers 250A and Larger: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.

2. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings with restricted access cover:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I^2t response.

3. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
4. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
5. AFCI Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
5. Shunt Trip: 120-V trip coil energized from separate circuit.
6. Do not use tandem circuit breakers.
7. Provide lock on devices for circuit breakers when called out on panel schedules with “LOD” designation.
8. Provide type GFEP circuit breakers for all self- regulating heating (snow melting and heat trace) cables branch circuits and where noted on panel schedules with “GFEP” designation
9. Provide GFCI circuit breaker when called out on panel schedules with “GFCI” designation.
10. Provide Arc-Fault Circuit Interrupters where indicated on panel schedule with “AFCI” designation.
11. Provide shunt trip breakers when called out on panel schedules with “STB” designation.
12. Provide smart controllable circuit breakers when called out on panel schedules with “SMT” designation.
13. Provide permanent padlockable handle for circuit breakers when called out on panel schedules with “PL” designation.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Provide permanent provisions for padlocking all overcurrent devices in Distribution Panelboards. Provisions shall remain in place whether or not lock is installed.

C. Provide permanent provisions for padlocking overcurrent devices in Branch Circuit Panelboards that serve equipment not provided with a local, lockable disconnecting means. Provisions shall remain in place whether or not lock is installed

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section “Hangers and Supports for Electrical Systems.”

C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads or created by retrofitting. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Coordinate final directory room names and numbers with Facility Engineer.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Perform electrical tests on all breakers and switches 200A and above or that constitute a component of an emergency distribution system. Main circuit breakers in branch circuit panelboards 225A and below are not required to be tested.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes equipment for utility company's electricity metering and electricity metering by Owner.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual. Include the following:

1. Electricity-metering equipment.

B. Shop Drawings for Electricity-Metering Equipment:

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For electricity-metering equipment to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power and communication services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. E-MON L.P.
2. National Meter Industries, Inc.
3. Osaki Meter Sales, Inc.
4. Power Measurement.
5. Square D; Schneider Electric.

B. Kilowatt-Hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.
3. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
4. Identification: Comply with Division 26 Section "Electrical Identification."
5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.

6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.

    a. Type: Split core.

7. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install equipment for utility company metering. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

3.2 FIELD QUALITY CONTROL

A. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.
5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Single and duplex receptacles
2. Receptacles with integral USB charger.
3. Ground-fault circuit interrupter receptacles
4. Single- and double-pole snap switches.
5. Device wall plates.
6. Floor service fittings

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. AFCI: Arc-fault circuit interrupter.

D. PVC: Polyvinyl chloride.

E. RFI: Radio-frequency interference.

F. SPD: Surge protective devices.

G. UTP: Unshielded twisted pair.

H. USB: Universal serial bus.

1.4 REFERENCES

A. DSCC W-C-596G: Federal Specification Connector, Electrical, Power, General Specification.

B. DSCC W-C-896F: Federal Specification Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

C. IEC 309-1, Part 1: General Requirements: Plugs, Socket-Outlets and Couplers for Industrial Purposes

D. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.

E. NEMA WD 1: General Requirements for Wiring Devices.

F. NEMA WD 6: Wiring Device – Dimensional Requirements.

G. UL 20: General-Use Snap Switches.

H. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

I. UL 486B: Wire Connectors for Use with Aluminum Conductors.

J. UL 498: Electrical Attachment Plugs and Receptacles.

K. UL 943: Ground Fault Circuit Interrupters.

L. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer’s catalog information showing dimensions, colors, and configurations for each type of product indicated.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.7 EXTRA MATERIALS

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. Floor Service Fittings: One for every 10, but no fewer than one.

PART 2 - PRODUCTS

2.1 GENERAL WIRING DEVICE REQUIREMENTS

A. Comply with NFPA 70, NEMA WD 1, NEMA WD 6, and UL498.

B. Device Color:

1. Wiring Devices Connected to Normal Power System: White or As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wall Switches: White or As selected by Architect, unless otherwise indicated.

2.2 STANDARD GRADE RECEPTACLES

A. Duplex Receptacle, NEMA 5-20R:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell Wiring Device-Kellems: BR20
b. Eaton/Arrow Hart Wiring Devices: BR20
c. Leviton: BR 20
d. Legrand, Pass & Seymour: CRB5362

B. Tamper-Resistant Duplex Receptacle, NEMA 5-20R:

1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell Wiring Device-Kellems: BR20TR

b. Eaton/Arrow Hart Wiring Devices: TRBR20
c. Leviton: TBR20
d. Legrand, Pass & Seymour: TR5352

C. Weather-Resistant Duplex Receptacle, NEMA 5-20R:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell Wire Device-Kellems: BR20WR
b. Eaton/Arrow Hart Wiring Devices: WRBR20
c. Leviton: WBR20
d. Legrand, Pass & Seymour: WR20TR

D. Weather- and Tamper-Resistant Duplex Receptacle, NEMA 5-20R:

1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell Wire Device-Kellems: BR20WRTR
b. Eaton/Arrow Hart Wiring Devices: TWRBR20
c. Leviton: TWR20
d. Legrand, Pass & Seymour: WR5352TR

2.3 GFCI RECEPTACLES

A. General:

1. Comply with UL 943

B. Duplex GFCI Receptacle, NEMA 5-20R:

1. Manufacturers: Subject to compliance with requirements, provide one of the following:

a. Hubbell Wiring Device-Kellems: GFRST20
b. Eaton/Arrow Hart Wiring Devices: SGF20
c. Leviton: GFNT2
d. Legrand, Pass & Seymour: 2097

C. Tamper-Resistant Duplex GFCI Receptacle, NEMA 5-20R:

1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide one of the following:

a. Hubbell Wiring Device-Kellems: GFTRST20
b. Eaton/Arrow Hart Wiring Devices: TRSGF20
c. Leviton: GFTR2
d. Legrand, Pass & Seymour: 2097TR

D. Tamper- and Weather-Resistant Duplex GFCI Receptacle, NEMA 5-20R:

1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide one of the following:

    a. Hubbell Wiring Device-Kellems: GFTWRST20
    b. Eaton/Arrow Hart Wiring Devices: TWRSGF20
    c. Leviton: GFWT2
    d. Legrand, Pass & Seymour: 2097TRWR

E. Weather-Resistant Duplex GFCI Receptacle, NEMA 5-20R:

1. Manufacturers: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart Wiring Devices WRSGF20
    b. Leviton: GFWR2
    c. Legrand, Pass & Seymour: 2097TRWR

F. Dead Front GFCI, 20A:

1. Manufacturers: Subject to compliance with requirements, provide one of the following:

    a. Hubbell Wiring Device-Kellems: GFBFST20
    b. Eaton/Arrow Hart Wiring Devices: SGF20
    c. Leviton: GFRBF
    d. Legrand, Pass & Seymour: 2087

2.4 STRAIGHT BLADE AND TWIST-LOCK RECEPTACLES, OTHER THAN NEMA 5-20R

A. Provide commercial specification grade straight blade and twist-lock receptacles with standard NEMA configurations in accordance with the “Special Receptacles” schedule included on the drawings.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Wiring Device-Kellems
2. Eaton/Arrow Hart Wiring Devices
3. Leviton
4. Legrand, Pass & Seymour

2.5 CORD REELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Reelcraft L4500 Series
2. Legrand, Pass & Seymour
3. Hubbell Wiring Device-Kellems
4. Daniel Woodhead

B. Description: Portable cord reel with portable outlet box and receptacle; steel construction NEMA 1 enclosure; adjustable cord stop; spring retractable with latch; 115V, 20A. rated and capable of being ceiling, wall or bench mounted.

C. Cord: 30 feet of 3 no. 12 SJO cord with strain relief. Coordinate exact length required with Owner.

D. Wiring device: Portable outlet box with liquidtight cord connector and one NEMA 5-20R duplex GFCI receptacle, outlet box and flip-top cover attached to end of cable reel. Coordinate exact type of receptacle and connector with Owner.

E. Electrical Connection: Provide 48 inch pigtail with NEMA 5-20P plug. Coordinate exact connection requirements with Owner.

2.6 WALL SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Toggle Type:

1. Hubbell Wiring Device-Kellems: 1220 Series
2. Eaton/Arrow Hart Wiring Devices: AH1220 Series
3. Leviton: 1220 Series
4. Legrand, Pass & Seymour: PS20AC Series

C. Rocker Type

1. Hubbell Wiring Device-Kellems: 2100 Series
2. Eaton/Arrow Hart Wiring Devices: 7630
3. Leviton: 5621 Series
4. Legrand, Pass & Seymour: 2624

D. Device body: Plastic handle**.**

E. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.

F. Snap Switches: Heavy Duty specification grade, quiet type; rated 20A., 120-277 V AC.

G. Provide single-pole, two-pole, three-way and four-way switches as indicated.

H. Provide pilot light where indicated. Switch shall be illuminated when the switch is off.

I. Provide key type where indicated. Furnish four keys to Owner.

J. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.

1. Switch: 20 A, 120/277-V ac.
2. Receptacle: NEMA WD 6, Configuration 5-20R.

2.7 WALL PLATES

A. Manufacturers:

1. Provide wall plates and corresponding wiring devices from same manufacturer.

B. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces:

a. 0.035-inch- thick, satin-finished stainless steel

3. Material for Unfinished Spaces:

a. Galvanized steel

4. Material for Wet Locations: Gasketed Cast aluminum with hinged cover and listed and labeled as Extra Duty Weatherproof While-In-Use.

a. Manufacturers:

1) Hubbell: MX3200
2) Red Dot Model: CKLSVU, Thomas & Betts
3) Intermatic: WP3110MXD
4) Leviton: IUM1V

5. Material for Damp Locations: Gasketed Cast aluminum with hinged cover and listed and labeled as Weatherproof.

a. Manufacturers:

1) Red Dot Model CCGV, ABB Installation Products
2) Eaton/Arrow Hart WLRD1
3) Legrand, Pass & Seymour
4) Intermatic: WP3110MXD

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.

C. Install devices and assemblies level, plumb, and square with building lines.

D. Arrangement of Devices:

1. Coordinate locations of outlet boxes provided under Division 26 Section "Raceways and Boxes" to obtain mounting heights indicated on Drawings.

2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.
3. Where multiple switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.
4. Install horizontally mounted receptacles with grounding pole on the left.
5. Install GFCI receptacles so that the “Push To Test” and “Reset” designations can be read correctly. If printed in both directions, install with ground pole on top.
6. Install switches with OFF position down.

E. Install cover plates on switch, receptacle, and blank outlets in finished areas.

F. Install weather-resistant type receptacles in all damp and wet locations.

G. Install weatherproof cover plates on receptacles in damp locations.

H. Install weatherproof While-In-Use cover plates on receptacles in wet locations.

I. Install tamper-resistant type receptacles in all locations as required by the NEC (406.12) and as indicated on plan.

J. Provide hospital-grade tamper-resistant receptacles in all areas where identified in the National Electrical Code (406.12(s) and 517.18(c)) (i.e., business offices, corridors, waiting areas, lobbies, etc.).

K. Use oversized plates for outlets installed in masonry walls.

L. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

M. Remove wall plates and protect devices and assemblies during painting.

N. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

O. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.
2. Wall Switches: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding." Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.

B. Connect wiring according to Division 26 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.

C. 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.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Inspect each wiring device for defects.
2. Operate each wall switch with circuit energized and verify proper operation.
3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Cartridge fuses rated 600 V and less for use in switches and controllers.
2. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 Sections include the following:

a. Let-through current curves for fuses with current-limiting characteristics.
b. Time-current curves, coordination charts and tables, and related data.
c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with:

1. NEMA FU 1 – Low Voltage Cartridge Fuses.
2. NFPA 70 – National Electrical Code.
3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
4. UL 198E – Class R Fuses.
5. UL 512 – Fuseholders.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

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. Fuses: Quantity equal to 10% percent of each fuse type and size, but no fewer than 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
3. Ferraz Shawmut, Inc.
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

1. Feeders: Class RK1, time delay.
2. Motor Branch Circuits: Class RK5, time delay.
3. Other Branch Circuits: Class RK1, time delay.

2.3 SPARE-FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch- thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: 30 inches high by 24 inches wide by 12 inches deep.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energization at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energization of the circuit in which it is applied.

B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

C. Install spare-fuse cabinet(s).

3.3 IDENTIFICATION

A. Install labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 26 Section “Fuses”.

1.2 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers.
4. Molded-case switches.

5. Enclosures.

B. Related Sections:

1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. GD: General duty.

B. GFCI: Ground-fault circuit interrupter.

C. HD: Heavy duty.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 REFERENCES

A. NECA 1: Practices for Good Workmanship in Electrical Contracting.

B. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches.

E. NEMA FU 1: Low Voltage Cartridge Fuses.

F. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

G. NEMA PB1.1: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

H. NFPA 70: National Electrical Code.

1.5 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current rating.
4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Sections include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 EXTRA MATERIALS

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. Spares: For the following:

a. Potential Transformer Fuses: 2 of each size and type.
b. Control-Power Fuses: 2 of each size and type
c. Fuses for Fusible Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.

2. Spare Indicating Lights: Six of each type installed.

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 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Industries, Inc.
4. Square D/Group Schneider.

B. Fusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, with clips or bolt pads to accommodate specified fuses, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Provide early break auxiliary contacts in motor disconnect switches for motors that are fed from variable frequency controllers.
2. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
3. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.

2.3 TOGGLE DISCONNECT SWITCH

A. Manufacturers:

1. Double Pole:

a. Hubbell 1372.
b. Leviton 6808G-DAC.
c. Pass & Seymour 7812.

d. Bryant 30102.

2. Three Pole:

a. Hubbell 1379.
b. Leviton 7810GD.
c. Pass & Seymour 7813.
d. Bryant 30103.

B. Description: Heavy duty, 30A, 600 volt, double or three pole as required, single throw, motor rated switch without overload protection. Provide NEMA 1 enclosure and padlock attachment.

2.4 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Industries, Inc.
4. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

C. Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
2. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Enclosure: Provide handle capable of being locked in the open position with padlock.

D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

E. Molded-Case Switch Accessories:

1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. Provide "dummy" trip unit where required for proper operation.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay. Provide "dummy" trip unit where required for proper operation.
5. Key Interlock Kit: Externally mounted to prohibit operation; key shall be removable only when switch is in off position.
6. Circuit breaker selection for primary

F. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

2.5 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Indoor Dry Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

3.3 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

C. Install switches with off position down.

D. Install NEMA KS 1 enclosed switch where indicated for motor loads ½ HP and larger and equipment loads greater than 30A.

E. Install toggle disconnect switch, surface mounted, where indicated for motor loads less than ½ HP and equipment loads 30A. and less.

F. Install fuses in fusible disconnect switches.

G. Install flexible liquid tight conduit from toggle disconnect switch to portable equipment. Leave a 6'-0" whip.

H. Install flexible liquid tight conduit from toggle disconnect switch to stationary equipment.

I. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.

J. Install equipment on exterior foundation walls at least one inch from wall to permit vertical flow of air behind breaker and switch enclosures.

K. Support enclosures independent of connecting conduit or raceway system.

L. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Electrical Identification."

C. Provide adhesive label as specified in Division 26 Section "Electrical Identification" on inside door of each switch indicating UL fuse class and size for replacement.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip and time delay settings to values as determined by the protective device coordination study.

3.7 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.
2. Reduced voltage controllers.
3. Multispeed controllers.

B. Related Sections include the following:

C. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

D. Shop Drawings: For each enclosed controller.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. UL listing for series rating of overcurrent protective devices in combination controllers.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring.

E. Qualification Data: For manufacturer.

F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.3 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current-Limiting Types.

C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.

D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses).

E. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.

F. NEMA AB 1 - Molded Case Circuit Breakers.

G. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

H. NEMA KS 1 - Enclosed Switches.

I. ANSI/NFPA 70 - National Electrical Code.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

C. 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.

D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prior to beginning work on any system, verify all existing conditions that affect the work and coordinate with all other trade Contractors. Determine that the work can be installed as indicated or immediately report to the Architect/Engineer errors, inconsistencies or ambiguities.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift large equipment only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

D. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of each contactor and indicate circuits controlled. Submit under provisions of 26 0010.

1.7 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 EXTRA MATERIALS

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. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.
3. Keys: Furnish 2 of each to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Danfoss Inc.; Danfoss Electronic Drives Div.
3. Eaton Corporation; Cutler-Hammer Products.
4. General Electrical Company; GE Industrial Systems.
5. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
6. Siemens/Furnas Controls.
7. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2.3 VARIABLE FREQUENCY CONTROLLERS

A. Refer to Division 20 “Variable Frequency Controllers.”

B. Equipment furnished by mechanical trades and installed by electrical trades.

2.4 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights: NEMA ICS 2, heavy-duty type.

C. Indicating Lights: Run (Red), off or ready (Green).

D. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) contacts.

E. Selector Switch: NEMA ISC 2, mounted in front cover to read “hand/off/auto,” provide auxiliary contact for auto position monitoring.

F. Control Relays: Auxiliary and adjustable time-delay relays.

G. Manufacturer provided nameplate shall be provided on controller enclosure. Nameplate shall contain the following information:

1. Manufacturer’s name or identification.
2. Voltage rating.
3. Current and/or horsepower rating.
4. Short-circuit current rating,

2.6 FACTORY FINISHES

A. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1), or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install freestanding equipment on concrete bases.

C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

D. Install motor control equipment and contactors in accordance with manufacturer’s instructions.

E. Select and install heater elements in motor starters to match installed motor characteristics.

F. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

3.5 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Electrical Identification."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.8 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters or Motor Control - Adjustable Speed Drive Systems." Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 1 Sections for Closeout Procedures and Demonstration and Training."

END OF SECTION 262913

SECTION 263213 - PACKAGED ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. This Section includes packaged engine generator sets for standby power supply with the following features:

1. Gas engine.
2. Unit-mounted and Remote-mounting control and monitoring.
3. Outdoor enclosure.

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
2. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

C. LP: Liquid petroleum.

1.4 SUBMITTALS

A. Product Data: Submit product data under provisions of Section 260010. Include the following:

1. Data on features, components, accessories ratings, and performance.
2. Thermal damage curve for generator.
3. Time-current characteristic curves for generator protective device.
4. Manufacturer’s anchorage and base recommendations.

B. Shop Drawings: Submit shop drawings under provisions of Section 260100. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Submit shop drawings showing plan and elevation views with overall interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
2. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
3. Internal Wiring Diagrams: For engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.

C. Qualification Data: For manufacturer.

D. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
4. Report of sound generation.

5. Certified report of exhaust emissions showing compliance with applicable EPA regulations.
6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
2. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

F. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged generator sets and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

E. 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.

F. Comply with NFPA 30.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. UL2200 Listed and labeled

J. Comply with NFPA 110 requirements for Level 2 emergency power supply system.

K. Comply with NECA/EGSA 404-2000 – Recommended Practice for Installing Generator Sets.

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

1. Provide engines used for standby applications that carry certification of compliance with current EPA emissions requirements or provide engines which comply with EPA emissions requirements and provide the necessary field testing to certify EPA emissions compliance.
2. Provide engines used for prime power applicants which carry certification of compliance with EPA emissions requirements. Engines which are compliant but require field certification are not acceptable.

M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in manufacture and installation of original equipment.

1.9 EXTRA MATERIALS

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. Fuses: One for every 10 of each type and rating, but not less than one of each.
2. Indicator Lamps: Two for every six of each type used, but not less than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Caterpillar; Engine Div.
2. Kohler Co; Generator Division.
3. Onan Corp./Cummins Power Generation; Industrial Business Group.
4. MTU/Onsite Energy.
5. Generac.

2.2 ENGINE-GENERATOR SET

A. Packaged engine-generator set shall be a coordinated assembly of compatible components.

B. Safety Standard: Comply with ASME B15.1 and UL 2200.

C. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.

D. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

E. Generator-set performance for sensitive loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
2. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
3. Steady-State Voltage Operational Bandwidth: 2 percent of rated output voltage from no load to full load.
4. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
5. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
6. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
7. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
8. Transient Frequency Performance: Less than 2-Hz variation for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

9. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
10. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
11. Excitation System: Permanent magnet generator driven brushless exciter. Performance shall be unaffected by voltage distortion caused by nonlinear load.
12. Start Time: Comply with NFPA 110, Type 10, system requirements.

F. Provide guards for all external rotating parts to prevent accidental injury. Guards shall be securely bolted to the generator but removable for maintenance. Guards shall be painted with a rust inhibiting primer and an epoxy based gloss topcoat. Guards shall comply with OSHA requirements.

G. Service Conditions:

1. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

a. Ambient Temperature: Minus 15 to plus 40 deg C.
b. Altitude: Rated for altitude at project location.

2.3 ENGINE

A. Fuel: Natural Gas

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:

1. Natural Gas

a. Carburetor.
b. Secondary Gas Regulator.
c. Fuel-Shutoff Solenoid Valve.
d. Flexible Fuel Connectors.

E. Coolant Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.

F. Governor: Adjustable Isochronous with speed sensing.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less at each of four sides.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation:

1. When mode-selector switch on the control and monitoring panel is in the automatic position, remote control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set.
2. When mode-selector switch is switched to the on position the generator set starts.
3. When mode-selector switch is switched to the off position it initiates generator set shutdown.
4. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
5. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 system.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

F. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

1. Overcrank

2. Coolant low temperature
3. High engine temperature pre-alarm.
4. High engine temperature
5. Low lube oil pressure pre-alarm
6. Low lube oil pressure
7. Overspeed
8. Low fuel main tank
9. Low coolant level
10. Generator set supplying load
11. Control switch not in auto position
12. High battery voltage
13. Low cranking voltage
14. Low voltage in battery
15. Battery charge AC failure

G. Remote Alarm Annunciator:

1. Labeled LED shall identify each alarm event.
2. Common audible signal shall sound for alarm conditions.
3. Silencing switch in face of panel shall silence signal without altering visual indication.
4. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
5. Cabinet and faceplate shall be surface mounted with brushed stainless steel.

H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Matched to generator thermal damage curve as closely as possible.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Mount unit in enclosure to meet ANSI/NEMA 250, Type 1 requirements. Adjacent to or integrated with control and monitoring panel.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with ANSI/NEMA MG 1

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: ANSI/NEMA MG 1: Class H or Class F.

D. Temperature Rise: 130 degrees C standby.

E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: ANSI/NEMA MG 1, open drip proof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Manual adjustment on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Provide sound attenuating enclosure to meet the sound criteria specified in Part 1, “Quality Assurance”
2. enclosure to meet the sound criteria specified in Part 1, “Quality Assurance”

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2.8 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2.9 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 energy converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.

C. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Beginning of installation means Installer accepts existing conditions.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with vibration isolation devices on concrete base.

1. Size concrete base as recommended by generator manufacturer.
2. The top of the concrete pad shall be a minimum of 4” above finished grade or adjacent finished floor.

3. Secure sets to anchor bolts installed in concrete bases.
4. Concrete base construction is specified in Division 26 Section "Hangers and Supports for Electrical Systems."
5. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Install fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Natural- and LP-gas piping, valves, and specialties for gas distribution outside the building are specified in Division 2 Section "Natural Gas Distribution."
2. Natural- and LP-gas piping, valves, and specialties for gas piping inside the building are specified in Division 23 Section "Fuel Gas Piping."

F. Ground equipment according to Division 26 Section "Grounding and Bonding."

G. Connect wiring according to Division 26 Section "Conductors and Cables."

H. 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.

3.4 IDENTIFICATION

A. Identify system components according to Division 23 Section "Mechanical Identification" and Division 26 “Section Electrical Identification."

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Provide full load test utilizing portable resistor test bank, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal. Coordinate with Division 26 Section "Transfer Switches"
2. During test, record the following at 20 minute intervals:

    a. Kilowatts.
    b. Amperes.
    c. Voltage.
    d. Coolant temperature.
    e. Room temperature.
    f. Frequency.
    g. Oil pressure.

3. Test alarm and shutdown circuits by simulating conditions.
4. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.15.2.1 and 7.22.1 (except for vibration baseline test). Certify compliance with test parameters.
5. Perform tests recommended by manufacturer.
6. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:

    a. Single-step full-load pickup test.

7. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

8. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
9. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
10. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
11. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

12. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
13. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line and compare measured levels with required values.

D. Coordinate tests with tests for transfer switches and run them concurrently.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

M. Inspect, test and adjust portable generator docking station.

1. Commission phase rotation monitor to match site electrical distribution.
2. Install instruction signs indicating bonding requirements to match building system.
3. Confirm proper operation of portable generator start circuit.
4. Confirm proper operation of MTS status and annunciation.

3.6 DEMONSTRATION

A. Provide systems demonstration for Owner, Construction Manager and Electrical Engineer.

B. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

C. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

1. Provide a minimum of two 3-hour training sessions for the Owner’s personnel. One session shall be conducted at time of start-up, the other within three months of start-up.
2. Training shall include: Review of maintenance procedures and schedule, trouble shooting procedures, demonstration of all alarm and safety functions with appropriate actions to be taken, and review of regular testing and exercising schedule including inspection and observation procedures.
3. Coordinate with demonstration and training required in Division 26 section “Transfer Switches”.

3.7 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters.

END OF SECTION 263213

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

B. Related Sections:

1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Operation and Maintenance Data: Submit under provision of Section “Electrical General Requirements”. For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Sections, include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
3. Include instructions for operating equipment under emergency conditions.
4. Document ratings of equipment and each major component.
5. Include routine preventive maintenance and lubrication schedule.
6. List special tools, maintenance materials, and replacement parts

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

C. UL 1008 - Standard for Automatic Transfer Switches, unless requirements of those specifications are stricter.

D. NFPA 70 - National Electrical Code, including use in standby systems in accordance with Articles 517, 700, 701 and 702

E. NFPA 110 - Standard for Emergency and Standby Power Systems

F. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)

G. IEEE Standard 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)

H. NEMA Standard ICS2-447 - AC Automatic Transfer Switches

I. IEC - Standard for Automatic Transfer Switches

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the transfer switch and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:

a. Emerson; ASCO Power Technologies, LP
b. Caterpillar; Engine Div.
c. Generac Power Systems, Inc.
d. GE Zenith Controls.
e. Kohler Co.; Generator Division.
f. Cummins Power Generation.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Provide fault-current and withstand ratings in accordance with UL 1008 standard's 1½ and 3 cycle long-time ratings. Transfer switches which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

C. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

I. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCH

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

G. Automatic Transfer-Switch Features

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulates normal-source failure.

6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
10. Engine Shutdown Contacts:

    a. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

11. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel annunciates conditions for indicated transfer switches. Annunciation includes the following:

    1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    2. Switch position.
    3. Switch in test mode.
    4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

    1. Indicating Lights: Grouped for each transfer switch monitored.
    2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
    4. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

B. Identify components according to Division 26 Section “Electrical Identification”.

3.2 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables.”

C. 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.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect , test, and adjust components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing.”

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Verify time-delay settings.
c. Verify pickup and dropout voltages by data readout or inspection of control settings.
d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Sections.

1. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes SPDs for low-voltage power, control, and communication equipment.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for devices with integral SPDs.

1.3 REFERENCES

A. ANSI/IEEE C62.32: IEEE Standard Test Specifications for Low-Voltage Air Gap Surge-Protective Devices (Excluding Valve and Expulsion Type Devices).

B. ANSI/IEEE C62.41: IEEE Guide on Surge Voltages in Low Voltage AC Power Circuits.

C. ANSI/IEEE C62.45: IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

D. MLS-STD-E220A: Military Test Method Standard, Method of Insertion Loss Measurement.

E. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

F. NEMA LS 1: Low Voltage Surge Protection Devices.

G. NETA ATS: Acceptance Testing Specifications: “Surge Arresters, Low-Voltage Surge Protection Devices”.

H. NFPA 70: National Electrical Code.

I. NFPA 75: Standard for the Protection of Electronic Computer/Data Processing Equipment.

J. UL 1283: Electromagnetic Interference Filters.

K. UL 1449 Third Edition: Surge Protective Devices.

1.4 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed voltage rating.

C. SPD: Surge Protective Devices.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include rated capacities, operating weights, dimensions, mounting provisions, operating characteristics, furnished specialties, and accessories.
2. Provide connection details and wiring diagrams indicating how SPD device is integrated within panelboards and switchgear.

B. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:

1. UL 1283.
2. UL 1449.

C. Field quality-control test reports, including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

D. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain SPD's and accessories through one source from a single manufacturer. SPD units integral to switchboards, distribution panelboards and branch circuit panelboards shall be warranted and supported by the panelboard manufacturer.

B. Product Options: Electrical performance of SPD is based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. 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.

D. Factory Testing: The specified system shall be factory-tested prior to shipment. Testing of each system shall include but not be limited to quality control checks, "Hi-Pot" tests per UL requirements, IEEE C62.41 Category B and C surge tests, UL ground leakage tests and operational and calibration tests.

E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

F. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices." Provide independent test reports demonstrating complete system performance showing compliance.

G. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Surge Protective Devices."

1.7 PROJECT CONDITIONS

A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Frequency: 47 to 63 Hz.
3. Operating Temperature: -40 to 140 deg F.
4. Humidity: 0 to 95 percent, noncondensing.
5. Altitude: Less than 20,000 feet above sea level.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

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. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cutler-Hammer, Inc.; Eaton Corporation.
2. General Electric Company.
3. Siemens Industries, Inc.
4. Square D; Schneider Electric.

2.2 SURGE PROTECTIVE DEVICE

A. Surge Protection Device Description: Sine-wave-tracking type, with the following features and accessories:

1. MOV technology for each suppression mode.
2. Fuses, rated at 200-kA interrupting capacity. Provide fusing for each suppression path.
3. Fabrication using bolted compression lugs for internal wiring. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in current-carrying paths.
4. Integral disconnect switch which has been tested to the surge current rating of the SP to match or exceed the fault current rating of the board. Use of circuit breakers for disconnecting means is acceptable.
5. LED indicator lights for power and protection status for each phase mounted in panelboard front cover:

    a. Green indicates fully operational circuit.
    b. Red indicates loss of protection.

6. EMI-RFI Noise Rejection: based on MIL-STD-E220A, 50-ohm standard Insertion Loss Test:

    a. 34dB at 100 kHz.
    b. 51dB at 1 MHz.
    c. 54dB at 10 MHz.
    d. 48dB at 100 MHz.

7. The maximum continuous operating voltage (MCOV) for all voltage configurations shall be 115% if nominal or greater.
8. Audible alarm, with silencing switch, to indicate when protection has failed.

9. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.

B. Peak Single-Impulse Surge Current Rating for service entrance equipment (B2 Rating): 240 kA per phase; 120 kA per mode based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond waveform. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current.

C. Connection Means:

1. Integral: Bus mounted, parallel connection
2. External: Cable connection, parallel wired.

D. Protection modes and UL 1449 Listed and Recognized Component Surge Voltage Rating for grounded wye circuits with voltages of 208Y/120V, 3-phase, 4-wire circuits shall not exceed the following:

1. Line to Neutral: 700V.
2. Line to Ground: 700V
3. Neutral to Ground: 700V
4. Line to Line: 1500V

2.3 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Surge protective devices shall be factory installed in all new distribution equipment.

B. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

1. Provide a dedicated disconnect for suppressor as indicated on one line or in panel schedules.

3.2 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect distribution equipment to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports. Test all service entrance and electronic grade panelboard suppressors.

1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

    a. Visual and Mechanical Inspection

        1) Inspect for physical damage and compare nameplate data with Drawings and Specifications.
        2) Inspect for proper mounting and adequate clearances.
        3) Check ground lead on each device for individual attachment to ground bus or ground electrode.

B. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain surge protection devices. Refer to Division 1.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Division 26 "Lighting Control Devices."

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lamp: LED and substrate as a replaceable assembly.

F. LED: Light-emitting diode.

G. Lumen: Measured output of lamp and luminaire, or both.

H. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project per IES LM-79 and IES LM-80.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products or certified by a qualified independent testing agency.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Qualification Data: For testing laboratory providing photometric data for luminaires.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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. Lamps: 5% attic stock of each type and rating installed. Furnish at least one of each type.
2. LED Drivers 5% attic stock of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: 1% attic stock of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: 5% attic stock of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. 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.

E. Comply with:

1. NFPA 70 - National Electrical Code.
2. NECA/IESNA 500-1998 – Recommended Practice for Installing Indoor Commercial Lighting Systems.
3. NECA/IESNA 502-1999 – Recommended Practice for Installing Industrial Lighting Systems.
4. Code of Federal Regulations (47 CFR 37342).
5. Michigan Department of Community Industry Services requirements that all lamps shall be protected from breakage. Exposed lamps are not acceptable for use in kitchen/food prep areas.

F. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five years or manufacturer's standard warranty length (whichever is longer) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRES (LIGHTING FIXTURES)

A. Provide Luminaires as included in specification 26 5700 "Luminaire Product Data." This section contains product data sheets from the basis of design manufacturer with annotations.

B. Acceptable alternate manufacturers are indicated on the product data sheets. Alternate manufacturer products shall be equal in all respects including materials, finishes, photometric performance and energy performance and shall include all options, features, and accessories identified.

C. The Luminaire schedule shown on the drawings is supplemental provided for convenience and reference only. The requirements of this section and 26 5700 shall govern.

2.2 LUMINAIRE 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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Unless otherwise specified in Luminaire product data, provide products with a minimum CRI of 80.

E. Unless otherwise specified in Luminaire product data, provide products with a CCT of 3500K.

F. Unless otherwise specified in Luminaire product data, provide products with an IES LM-80 rated lamp life of 50,000 hours.

G. Driver

1. Provided as an integrated component of the luminaire or as an external component of an assembly of luminaries.
2. Nominal Input Voltage: All drivers shall be rated for use on either 120V or 277V systems.

2.3 EXIT SIGNS

A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps: Light-emitting diodes, 70,000 hours minimum of rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

D. Provide edge lit signs with a mirror plaque background.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598 Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.6 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: Unless otherwise specified in Luminaire product data, provide products with a minimum 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: Unless otherwise specified in Luminaire product data, provide products with a minimum ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: Unless otherwise specified in Luminaire product data, provide products with a minimum 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

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 luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. Do not use permanent luminaires for temporary lighting.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and N.E.C.A./I.E.S.N.A. 500-2006 and 502-2006.

B. Locate ceiling luminaires as indicated on reflected ceiling plan.

C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

D. Support luminaires independent of ceiling framing. Support recessed grid luminaries from two opposite corners directly to structure. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Exposed Grid Ceilings: Provide auxiliary members spanning ceiling T's (above) to support surface mounted luminaires.

F. Install recessed luminaires to permit removal from below.

G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

H. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

I. Install fixture with no gaps between adjacent fixtures or between fixtures and surrounding surfaces. Trims of fixtures shall be properly and uniformly aligned.

J. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

K. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

L. Wall-Mounted Luminaire Support:

1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
2. Do not attach luminaires directly to gypsum board.

M. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.

N. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

O. Comply with requirements in Section 260519 "Conductors and Cables" for wiring connections.

P. Fixtures shall have their exterior labels removed and shall be thoroughly cleaned.

Q. Locate the remote test/monitor modules identically so that they are visible and they form a straight line when viewed from the end of the corridor or room. Where a suspended ceiling exists, center the modules in adjacent ceiling tiles.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

C. Bond products and metal accessories to branch circuit equipment grounding conductor.

D. Connect luminaires to branch circuit outlet boxes provided under Division 26 Section "Raceways and Boxes" using 1/2" flexible conduit.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. A visual inspection shall be performed to verify cleanliness and alignment of the fixtures, misalignment and light leaks shall be corrected, and rattles due to ventilation system vibration shall be eliminated.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps, drivers, or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

B. Adjust exit sign directional arrows as indicated on Drawings.

C. Adjust and calibrate all dimming system controls until the system works as designed. Contact the Architect/Engineer when dimming is complete and demonstrate operation to owner’s representative and Architect/Engineer.

3.8 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures and lenses.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

END OF SECTION 265119

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

B. Related Sections include the following:

1. Division 26 Section "LED Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. HID: High-intensity discharge.

C. Luminaire: Complete lighting fixture, including ballast housing if provided.

D. Pole: Luminaire support structure, including tower used for large area illumination.

E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Ice Load: Load of 3 lb/sq. ft., applied as stated in AASHTO LTS-4.

C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

    a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.
12. Manufactured pole foundations.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Wiring Diagrams: Power and control wiring.

C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

D. Qualification Data: For agencies providing photometric data for lighting fixtures.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.

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. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: Dark bronze. Coordinate final finish with Architect.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.4 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

2.5 ALUMINUM POLES

A. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: Square, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as pole and luminaire.

E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: Dark bronze and coordinated with Architect from manufacturer's full range.

2.6 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.

1. Recessed, 12 inches above foundation.
2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, dark bronze color to match pole, that when mounted results in NEMA 250, Type 3R enclosure.
3. With cord opening.
4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

C. Vibration Dampener: For all steel and aluminum lighting poles taller than 25', provide factory installed vibration dampening device to eliminate second mode or higher resonance that can occur with low velocity steady state winds.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install exterior lighting system per N.E.C.A./I.E.S.N.A. 501-2006.

B. Install lamps in each luminaire.

C. Fasten luminaire to indicated structural supports.

D. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
2. Install base covers, unless otherwise indicated.
3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding."

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding."

3.6 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 1 Section "Demonstration and Training.

END OF SECTION 265600

L1

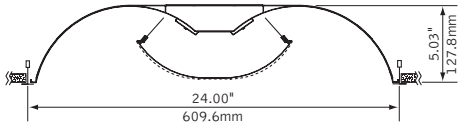
PROVIDE SPECIFIED FIXTURE, METALUX 22RDI, ORACLE 22-OD-LED, OR ENGINEER APPROVED EQUAL.

Luna® 2x2

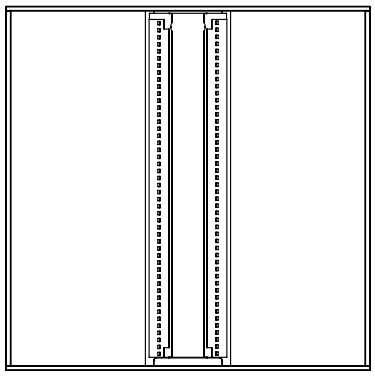
LED

FOCAL POINT®

DIMENSIONAL DATA



Overall height of ST luminaire is 5.5"



2 LED boards

FEATURES

Architectural recessed LED luminaire with perforated center basket.

Classic style updated with the latest technology.

Reflector and end caps form seamless one-piece housing.

High reflectance, low gloss Matte White finish controls glare.

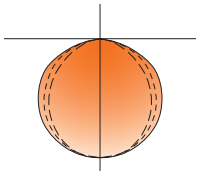
Comparable output to fluorescent versions with reduced wattage.

Luna® LED provides high angle uniform distribution ideal for comfortable general illumination.

Connected Solutions: Integrates with wired and wireless building lighting control systems.

Preferred Light: Lighting for better color rendition and human preference.

PERFORMANCE



Delivered Lumens: 2500lm

Total System Watts: 28W

PRODUCT OVERVIEW

Lumen Output:	2000-4000lm
Wattage:	23-48W
LPW:	84-89
SDCM:	3

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

fixture: project:

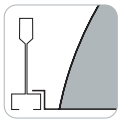
L1

MOUNTING INFORMATION

grid

specify "G" for flat 9/16" and 15/16" tee or "ST" for 9/16" slot tee grid types.

"G" flat tee

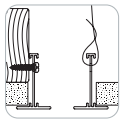


"ST" slot tee

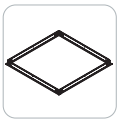
Overall height for ST luminaire is 5.50".

drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.



cut out dimensions:
2': Min: 24.25"
Max: 24.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with CRI>80 or CRI>90. 0-10V dimming driver standard. LED modules and drivers are replaceable.

Construction

One-piece 20 Ga. steel reflector and housing. 20 Ga. steel ends form finished housing. LEDs are shielded by detachable 22 Ga. steel perforated shield with acrylic lens insert. LED shield is secured by four spring–pins allowing shield to hinge down for maintenance. Top access 20 Ga. steel driver compartment. Weight: 29 lbs.

Optic

One-piece 20 Ga. steel reflectors finished in Matte Satin White powder coat.

Electrical

Standard 120-277V driver includes 0-10V analog dimming, dimming range 100% - 10% Power factor > .9.

Emergency

Emergency battery output—10 watts for 90 minutes. High Output emergency battery—20 watts for 90 minutes (U.S. only). Emergency Circuit with Connected Solutions (NLT1, ENL1, CLM1, CLMZ1, DLM1) requires a UL924 compliant device, consult factory.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre–treatment. Optional Anti-Microbial paint finish available.

Lumen Maintenance

Reported: L70 > 60,000 hours
L80 > 60,000 hours

Calculated: L70 at > 124,000 hours
L80 at > 78,000 hours

(Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.)

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Lifetime and warranty

LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Delivered Lumens	Tested System Watts	LPW
2000 Lumens	23	89
2500 Lumens	28	88
3000 Lumens	34	87
3500 Lumens	41	85
4000 Lumens	48	84

Based on 3500K, 80 CRI. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

Focal Point LLC reserves the right to change specifications for product improvement without notification.

ORDERING

		FLUL
Luminaire Series		
Luna LED	FLUL	
Nominal Size		22
2' x 2'	22	
Shielding		PS
Perforated Shield	PS	
Lumen Output		
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
3500 Lumens	3500L	
4000 Lumens (LD1 & L11 only)	4000L	
Color Temperature		
2700K, 80+ CRI **or** 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 90+ CRI	40K **or** 940K	
3500K, Preferred Light	P35K	
Circuit		1C
Single Circuit	1C	
Voltage		
UNV 120/277 Volt	UNV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
Lutron 5-Series EcoSystem (LDE5) - 5% Dimming	LU5	
Acuity nLight - 1% Dimming (Not available with CP)	NLT1	
Enlighted Smart Sensor - 1% Dimming	ENL1	
Osram Connected Lighting Module for ENCELIUM systems - 1% Dimming (Compatible with Osram ENCELIUM and ENCELIUM EDGE systems only)	CLM1	
Osram Connected Lighting Module for ZigBee Wireless Networks - 1% Dimming (Not compatible with Osram ENCELIUM systems)	CLMZ1	
Wattstopper DLM - 1% Dimming	DLM1	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
Drywall Frame Kit (LD1, L11, LH1 & LU5 only) (Cut out dimensions: Min: 24.25"/Max: 24.563")	F	
Grid	G	
Slot Tee	ST	
Surface Mount (Not available with DLM1 or NLT1)	SM	
Factory Options		
Air Return (Adds 0.875" to overall height)	AR	
Chicago Plenum	CP	
Emergency Battery (Adds 3.25" to overall height)	B310	
High Output Emergency Battery (Adds 3.25" to overall height. U.S. Only)	B20	
Positional Clips	EQ	
6' New York City Flex Whip (120V)	FNY1	
6' New York City Flex Whip (277V)	FNY2	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White Anti–Microbial	WHA	

PROVIDE EMERGENCY BATTERY FOR EM LABELED FIXTURES

FINISH/COLOR AS SELECTED BY ARCHITECT.

QS 5/10 DAY Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

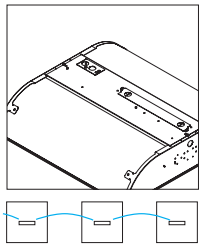
For more information visit focalpointlights.com/reference or consult factory.

L1

Luna® 2x2 LED

CONNECTED™ SOLUTIONS

Focal Point provides flexibility in meeting the needs of each project by integrating with several building lighting control systems. A variety of sensors, drivers and other components can be specified that allow the luminaires to communicate with wired and wireless networks. All zoning can be digitally reconfigured through the application software. Daylight harvesting, occupancy sensing, integration with HVAC systems, and individual controls enable the monitoring and modulating of light levels and temperature in order to save energy, reduce costs and maximize occupants' comfort. All Connected Solutions luminaires require a compatible building control system.†



nLIGHT

nLight® provides a two-way wired digital lighting system allowing for on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting.

Acuity nLight - 1% Dimming (NLT1)
Acuity Model #nEPS-60-IO

CAT-5 Cable provided by others.Serial labels will be provided on outside of luminaires and control unit.

enlighted
A Siemens Company

Enlighted smart sensor allows for occupancy sensing, daylight harvesting, energy usage, temperature and light level control. Communicates wirelessly with the Enlighted network.

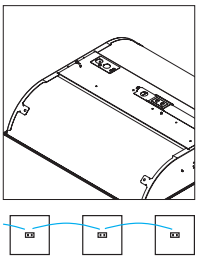
Enlighted Smart Sensor - 1% Dimming (ENL1)
Enlighted Model #SU-5E-IOT

OSRAM

Connected Lighting Module (CLM) enables each luminaire to be independently controlled and configured. Communicates wirelessly with Daintree Networks®, Osram ENCELIUM®, Osram ENCELIUM EDGE™, and other networks using the ZigBee® HA communication protocol to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Osram CLM - 1% Dimming (CLM1 & CLMZ1)
Osram Model #ZBHA-CLM DIM

Serial labels will be provided on outside of luminaires and control unit.

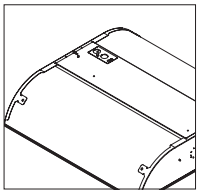


legrand® WATTSTOPPER®

A Digital Lighting Management (DLM) system that provides two-way wired communication between networked luminaires and control system to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Wattstopper DLM - 1% Dimming (DLM1)
Wattstopper Model #LMFC-011

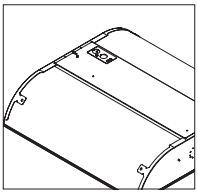
CAT-5 Cable provided by others. Serial labels will be provided on outside of luminaires and control unit.



LUTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting working with Quantum®, Energi Savr Node™, and Energi TriPak® using EcoSystem® communication protocol.

Lutron Hi-Lume EcoSystem - 1% Dimming (LH1)
Lutron Model #LDE1
Lutron 5-Series EcoSystem - 5% Dimming (LU5)
Lutron Model #LDE5



CRESTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting. Communicates with Zūm wireless and SpaceBuilder working with Zūm hub scheduling or FUSION management.

0-10V - 1% Dimming (L11)
Note: 0-10V is not a digital network but is compatible with Creston Zūm™ system.

CONNECTED SOLUTIONS DETAILS

Connected Solution	Model #	Protocol	Compatible Networks*	Occupancy	Daylight	Temperature Reporting	Communication to Luminaire	Drivers
Acuity nLight (NLT1)	nEPS-60-IO**	nLight	nLight	Enabled	Enabled	No	Wired	**eldoLED ECOdrive,** eldoLED SOLOdrive
Crestron (L11)	Specified Driver	0-10V	Crestron Zūm Wireless & SpaceBuilder	Enabled	Enabled	No	Wired	**Advance by Signify**
Enlighted Smart Sensor (ENL1)	SU-5E-IOT**	Enlighted RF	Enlighted	Integrated	Integrated	Yes	Wireless	**Osram Optotronic,** Advance by Signify
Legrand Wattstopper DLM (DLM1)	LMFC-011**	DLM	DLM	Enabled	Enabled	No	Wired	**Osram Optotronic,** Advance by Signify
Lutron EcoSystem (LH1 & LU5)	LDE1,** LDE5**	EcoSystem	Quantum, Energi Savr Node, Energi TriPak	Enabled	Enabled	No	Wired	**Lutron Hi-Lume Lutron 5-Series**
Osram CLM for ENCELIUM systems (CLM1)	ZBHA-CLM**	ZigBee HA	Osram ENCELIUM & ENCELIUM EDGE	Enabled	Enabled	No	Wireless	**Osram Optotronic**
Osram CLM for ZigBee Wireless Networks (CLMZ1)	ZBHA-CLM**	ZigBee HA	Daintree Networks & open ZigBee Networks	Enabled	Enabled	No	Wireless	**Osram Optotronic**

*Not all compatible networks may be listed. **For performance data and additional control system details please visit the connected solutions manufacturer websites. Primary drivers are listed in **bold.** To specify a particular driver please consult factory. †Controls systems supplied by others.

PARTNERS 21-146A
LUMINAIRE PRODUCT DATA
265700 - 4

Luna® 2x2

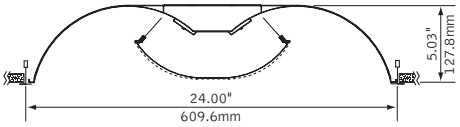
LED

L1A

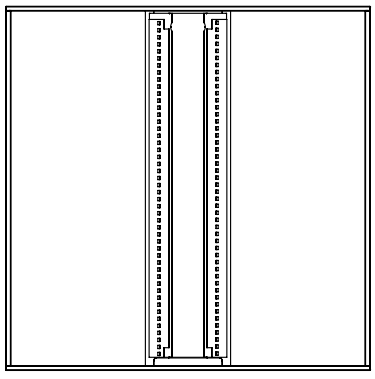
PROVIDE SPECIFIED FIXTURE, METALUX 22RDI, ORACLE 22-OD-LED, OR ENGINEER APPROVED EQUAL.

FOCAL POINT®

DIMENSIONAL DATA



Overall height of ST luminaire is 5.5"



2 LED boards

FEATURES

Architectural recessed LED luminaire with perforated center basket.

Classic style updated with the latest technology.

Reflector and end caps form seamless one-piece housing.

High reflectance, low gloss Matte White finish controls glare.

Comparable output to fluorescent versions with reduced wattage.

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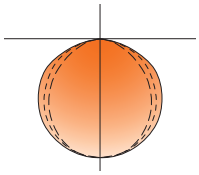
Preferred Light: Lighting for better color rendition and human preference.

PERFORMANCE



Delivered Lumens: 2500lm

Total System Watts: 28W

PRODUCT OVERVIEW

Lumen Output:	2000-4000lm
Wattage:	23-48W
LPW:	84-89
SDCM:	3

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

JUNE 13, 2023 / BIDDING - CONSTRUCTION

fixture: project:

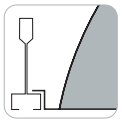
L1A

MOUNTING INFORMATION

grid

specify "G" for flat 9/16" and 15/16" tee or "ST" for 9/16" slot tee grid types.

"G" flat tee

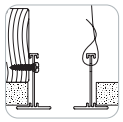


"ST" slot tee

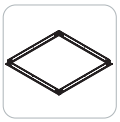
Overall height for ST luminaire is 5.50".

drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.



cut out dimensions:
2': Min: 24.25"
Max: 24.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with CRI>80 or CRI>90. 0-10V dimming driver standard. LED modules and drivers are replaceable.

Construction

One-piece 20 Ga. steel reflector and housing. 20 Ga. steel ends form finished housing. LEDs are shielded by detachable 22 Ga. steel perforated shield with acrylic lens insert. LED shield is secured by four spring–pins allowing shield to hinge down for maintenance. Top access 20 Ga. steel driver compartment. Weight: 29 lbs.

Optic

One-piece 20 Ga. steel reflectors finished in Matte Satin White powder coat.

Electrical

Standard 120-277V driver includes 0-10V analog dimming, dimming range 100% - 10% Power factor > .9.

Emergency

Emergency battery output—10 watts for 90 minutes. High Output emergency battery—20 watts for 90 minutes (U.S. only). Emergency Circuit with Connected Solutions (NLT1, ENL1, CLM1, CLMZ1, DLM1) requires a UL924 compliant device, consult factory.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre–treatment. Optional Anti-Microbial paint finish available.

Lumen Maintenance

Reported: L70 > 60,000 hours
L80 > 60,000 hours

Calculated: L70 at > 124,000 hours
L80 at > 78,000 hours

(Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.)

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Lifetime and warranty

LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Delivered Lumens	Tested System Watts	LPW
2000 Lumens	23	89
2500 Lumens	28	88
3000 Lumens	34	87
3500 Lumens	41	85
4000 Lumens	48	84

Based on 3500K, 80 CRI. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

Focal Point LLC reserves the right to change specifications for product improvement without notification.

ORDERING

Luminaire Series		**FLUL**
Luna LED	FLUL	
Nominal Size		**22**
2' x 2'	22	
Shielding		**PS**
Perforated Shield	PS	
Lumen Output		
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
3500 Lumens	3500L	
4000 Lumens (LD1 & L11 only)	4000L	
Color Temperature		
2700K, 80+ CRI **or** 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 90+ CRI	40K **or** 940K	
3500K, Preferred Light	P35K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
UNV 120/277 Volt	UNV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
Lutron 5-Series EcoSystem (LDE5) - 5% Dimming	LU5	
Acuity nLight - 1% Dimming (Not available with CP)	NLT1	
Enlighted Smart Sensor - 1% Dimming	ENL1	
Osram Connected Lighting Module for ENCELIUM systems - 1% Dimming (Compatible with Osram ENCELIUM and ENCELIUM EDGE systems only)	CLM1	
Osram Connected Lighting Module for ZigBee Wireless Networks - 1% Dimming (Not compatible with Osram ENCELIUM systems)	CLMZ1	
Wattstopper DLM - 1% Dimming	DLM1	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
Drywall Frame Kit (LD1, L11, LH1 & LU5 only) (Cut out dimensions: Min: 24.25"/Max: 24.563")	F	
Grid	G	
Slot Tee	ST	
Surface Mount (Not available with DLM1 or NLT1)	SM	
Factory Options		
Air Return (Adds 0.875" to overall height)	AR	
Chicago Plenum	CP	
Emergency Battery (Adds 3.25" to overall height)	B310	
High Output Emergency Battery (Adds 3.25" to overall height. U.S. Only)	B20	
Positional Clips	EQ	
6' New York City Flex Whip (120V)	FNY1	
6' New York City Flex Whip (277V)	FNY2	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White Anti–Microbial	WHA	

PROVIDE EMERGENCY BATTERY FOR EM LABELED FIXTURES

FINISH/COLOR AS SELECTED BY ARCHITECT.

QS 5/10 DAY Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

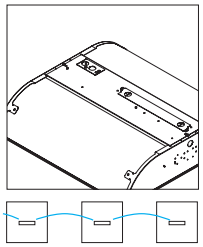
For more information visit focalpointlights.com/reference or consult factory.

L1A

CONNECTED™ SOLUTIONS

Luna® 2x2 LED

Focal Point provides flexibility in meeting the needs of each project by integrating with several building lighting control systems. A variety of sensors, drivers and other components can be specified that allow the luminaires to communicate with wired and wireless networks. All zoning can be digitally reconfigured through the application software. Daylight harvesting, occupancy sensing, integration with HVAC systems, and individual controls enable the monitoring and modulating of light levels and temperature in order to save energy, reduce costs and maximize occupants' comfort. All Connected Solutions luminaires require a compatible building control system.†



nLIGHT

nLight® provides a two-way wired digital lighting system allowing for on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting.

Acuity nLight - 1% Dimming (NLT1)
Acuity Model #nEPS-60-IO

CAT-5 Cable provided by others.Serial labels will be provided on outside of luminaires and control unit.

enlighted
A Siemens Company

Enlighted smart sensor allows for occupancy sensing, daylight harvesting, energy usage, temperature and light level control. Communicates wirelessly with the Enlighted network.

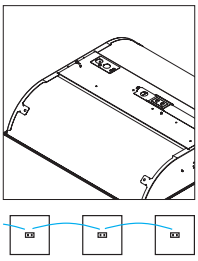
Enlighted Smart Sensor - 1% Dimming (ENL1)
Enlighted Model #SU-5E-IOT

OSRAM

Connected Lighting Module (CLM) enables each luminaire to be independently controlled and configured. Communicates wirelessly with Daintree Networks®, Osram ENCELIUM®, Osram ENCELIUM EDGE™, and other networks using the ZigBee® HA communication protocol to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Osram CLM - 1% Dimming (CLM1 & CLMZ1)
Osram Model #ZBHA-CLM DIM

Serial labels will be provided on outside of luminaires and control unit.

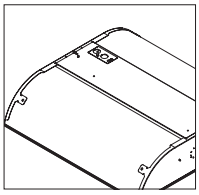


legrand® WATTSTOPPER®

A Digital Lighting Management (DLM) system that provides two-way wired communication between networked luminaires and control system to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Wattstopper DLM - 1% Dimming (DLM1)
Wattstopper Model #LMFC-011

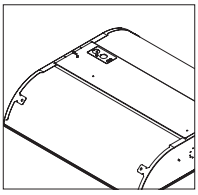
CAT-5 Cable provided by others. Serial labels will be provided on outside of luminaires and control unit.



LUTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting working with Quantum®, Energi Savr Node™, and Energi TriPak® using EcoSystem® communication protocol.

Lutron Hi-Lume EcoSystem - 1% Dimming (LH1)
Lutron Model #LDE1
Lutron 5-Series EcoSystem - 5% Dimming (LU5)
Lutron Model #LDE5



CRESTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting. Communicates with Zūm wireless and SpaceBuilder working with Zūm hub scheduling or FUSION management.

0-10V - 1% Dimming (L11)
Note: 0-10V is not a digital network but is compatible with Creston Zūm™ system.

CONNECTED SOLUTIONS DETAILS

Connected Solution	Model #	Protocol	Compatible Networks*	Occupancy	Daylight	Temperature Reporting	Communication to Luminaire	Drivers
Acuity nLight (NLT1)	nEPS-60-IO**	nLight	nLight	Enabled	Enabled	No	Wired	**eldoLED ECOdrive,** eldoLED SOLOdrive
Crestron (L11)	Specified Driver	0-10V	Crestron Zūm Wireless & SpaceBuilder	Enabled	Enabled	No	Wired	**Advance by Signify**
Enlighted Smart Sensor (ENL1)	SU-5E-IOT**	Enlighted RF	Enlighted	Integrated	Integrated	Yes	Wireless	**Osram Optotronic**, Advance by Signify
Legrand Wattstopper DLM (DLM1)	LMFC-011**	DLM	DLM	Enabled	Enabled	No	Wired	**Osram Optotronic**, Advance by Signify
Lutron EcoSystem (LH1 & LU5)	LDE1;** LDE5**	EcoSystem	Quantum, Energi Savr Node, Energi TriPak	Enabled	Enabled	No	Wired	**Lutron Hi-Lume Lutron 5-Series**
Osram CLM for ENCELIUM systems (CLM1)	ZBHA-CLM**	ZigBee HA	Osram ENCELIUM & ENCELIUM EDGE	Enabled	Enabled	No	Wireless	**Osram Optotronic**
Osram CLM for ZigBee Wireless Networks (CLMZ1)	ZBHA-CLM**	ZigBee HA	Daintree Networks & open ZigBee Networks	Enabled	Enabled	No	Wireless	**Osram Optotronic**

*Not all compatible networks may be listed. **For performance data and additional control system details please visit the connected solutions manufacturer websites. Primary drivers are listed in **bold.** To specify a particular driver please consult factory. †Controls systems supplied by others.

L1B

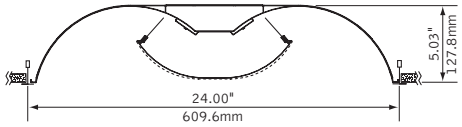
PROVIDE SPECIFIED FIXTURE, METALUX 22RDI, ORACLE 22-OD-LED, OR ENGINEER APPROVED EQUAL.

Luna® 2x2

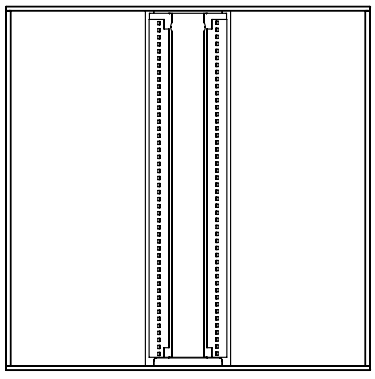
LED

FOCAL POINT®

DIMENSIONAL DATA



Overall height of ST luminaire is 5.5"



2 LED boards

FEATURES

Architectural recessed LED luminaire with perforated center basket.

Classic style updated with the latest technology.

Reflector and end caps form seamless one-piece housing.

High reflectance, low gloss Matte White finish controls glare.

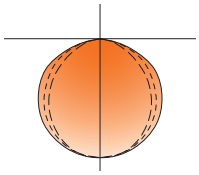
Comparable output to fluorescent versions with reduced wattage.

Luna® LED provides high angle uniform distribution ideal for comfortable general illumination.

Connected Solutions: Integrates with wired and wireless building lighting control systems.

Preferred Light: Lighting for better color rendition and human preference.

PERFORMANCE



Delivered Lumens: 2500lm

Total System Watts: 28W

PRODUCT OVERVIEW

Lumen Output:	2000-4000lm
Wattage:	23-48W
LPW:	84-89
SDCM:	3

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

fixture: project:

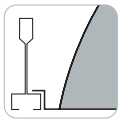
L1B

MOUNTING INFORMATION

grid

specify "G" for flat 9/16" and 15/16" tee or "ST" for 9/16" slot tee grid types.

"G" flat tee

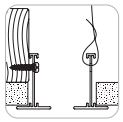


"ST" slot tee

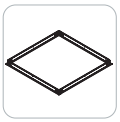
Overall height for ST luminaire is 5.50".

drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.



cut out dimensions:
2': Min: 24.25"
Max: 24.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with CRI>80 or CRI>90. 0-10V dimming driver standard. LED modules and drivers are replaceable.

Construction

One-piece 20 Ga. steel reflector and housing. 20 Ga. steel ends form finished housing. LEDs are shielded by detachable 22 Ga. steel perforated shield with acrylic lens insert. LED shield is secured by four spring–pins allowing shield to hinge down for maintenance. Top access 20 Ga. steel driver compartment. Weight: 29 lbs.

Optic

One-piece 20 Ga. steel reflectors finished in Matte Satin White powder coat.

Electrical

Standard 120-277V driver includes 0-10V analog dimming, dimming range 100% - 10% Power factor > .9.

Emergency

Emergency battery output—10 watts for 90 minutes. High Output emergency battery—20 watts for 90 minutes (U.S. only). Emergency Circuit with Connected Solutions (NLT1, ENL1, CLM1, CLMZ1, DLM1) requires a UL924 compliant device, consult factory.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre–treatment. Optional Anti-Microbial paint finish available.

Lumen Maintenance

Reported: L70 > 60,000 hours
L80 > 60,000 hours

Calculated: L70 at > 124,000 hours
L80 at > 78,000 hours

(Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.)

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Lifetime and warranty

LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Delivered Lumens	Tested System Watts	LPW
2000 Lumens	23	89
2500 Lumens	28	88
3000 Lumens	34	87
3500 Lumens	41	85
4000 Lumens	48	84

Based on 3500K, 80 CRI. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

ORDERING

		FLUL
Luminaire Series		
Luna LED	FLUL	
Nominal Size		22
2' x 2'	22	
Shielding		PS
Perforated Shield	PS	
Lumen Output		
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
3500 Lumens	3500L	
4000 Lumens (LD1 & L11 only)	4000L	
Color Temperature		
2700K, 80+ CRI **or** 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 90+ CRI	40K **or** 940K	
3500K, Preferred Light	P35K	
Circuit		1C
Single Circuit	1C	
Voltage		
UNV 120/277 Volt	UNV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
Lutron 5-Series EcoSystem (LDE5) - 5% Dimming	LU5	
Acuity nLight - 1% Dimming (Not available with CP)	NLT1	
Enlighted Smart Sensor - 1% Dimming	ENL1	
Osram Connected Lighting Module for ENCELIUM systems - 1% Dimming (Compatible with Osram ENCELIUM and ENCELIUM EDGE systems only)	CLM1	
Osram Connected Lighting Module for ZigBee Wireless Networks - 1% Dimming (Not compatible with Osram ENCELIUM systems)	CLMZ1	
Wattstopper DLM - 1% Dimming	DLM1	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
Drywall Frame Kit (LD1, L11, LH1 & LU5 only) (Cut out dimensions: Min: 24.25"/Max: 24.563")	F	
Grid	G	
Slot Tee	ST	
Surface Mount (Not available with DLM1 or NLT1)	SM	
Factory Options		
Air Return (Adds 0.875" to overall height)	AR	
Chicago Plenum	CP	
Emergency Battery (Adds 3.25" to overall height)	B310	
High Output Emergency Battery (Adds 3.25" to overall height. U.S. Only)	B20	
Positional Clips	EQ	
6' New York City Flex Whip (120V)	FNY1	
6' New York City Flex Whip (277V)	FNY2	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White Anti–Microbial	WHA	

PROVIDE EMERGENCY BATTERY FOR EM LABELED FIXTURES

FINISH/COLOR AS SELECTED BY ARCHITECT.

QS 5/10 DAY Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

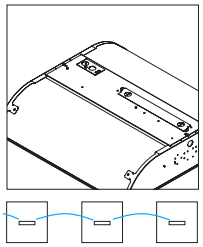
For more information visit focalpointlights.com/reference or consult factory.

L1B

CONNECTED™ SOLUTIONS

Luna® 2x2 LED

Focal Point provides flexibility in meeting the needs of each project by integrating with several building lighting control systems. A variety of sensors, drivers and other components can be specified that allow the luminaires to communicate with wired and wireless networks. All zoning can be digitally reconfigured through the application software. Daylight harvesting, occupancy sensing, integration with HVAC systems, and individual controls enable the monitoring and modulating of light levels and temperature in order to save energy, reduce costs and maximize occupants' comfort. All Connected Solutions luminaires require a compatible building control system.†



nLIGHT

nLight® provides a two-way wired digital lighting system allowing for on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting.

Acuity nLight - 1% Dimming (NLT1)
Acuity Model #nEPS-60-IO

CAT-5 Cable provided by others.Serial labels will be provided on outside of luminaires and control unit.

enlighted
A Siemens Company

Enlighted smart sensor allows for occupancy sensing, daylight harvesting, energy usage, temperature and light level control. Communicates wirelessly with the Enlighted network.

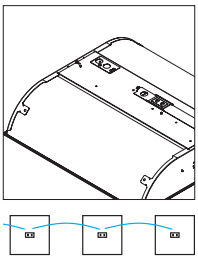
Enlighted Smart Sensor - 1% Dimming (ENL1)
Enlighted Model #SU-5E-IOT

OSRAM

Connected Lighting Module (CLM) enables each luminaire to be independently controlled and configured. Communicates wirelessly with Daintree Networks®, Osram ENCELIUM®, Osram ENCELIUM EDGE™, and other networks using the ZigBee® HA communication protocol to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Osram CLM - 1% Dimming (CLM1 & CLMZ1)
Osram Model #ZBHA-CLM DIM

Serial labels will be provided on outside of luminaires and control unit.

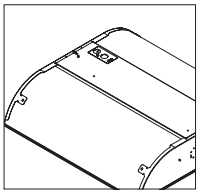


legrand® WATTSTOPPER®

A Digital Lighting Management (DLM) system that provides two-way wired communication between networked luminaires and control system to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Wattstopper DLM - 1% Dimming (DLM1)
Wattstopper Model #LMFC-011

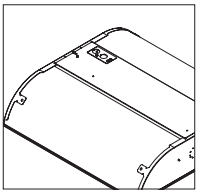
CAT-5 Cable provided by others. Serial labels will be provided on outside of luminaires and control unit.



LUTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting working with Quantum®, Energi Savr Node™, and Energi TriPak® using EcoSystem® communication protocol.

Lutron Hi-Lume EcoSystem - 1% Dimming (LH1)
Lutron Model #LDE1
Lutron 5-Series EcoSystem - 5% Dimming (LU5)
Lutron Model #LDE5



CRESTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting. Communicates with Zūm wireless and SpaceBuilder working with Zūm hub scheduling or FUSION management.

0-10V - 1% Dimming (L11)
Note: 0-10V is not a digital network but is compatible with Creston Zūm™ system.

CONNECTED SOLUTIONS DETAILS

Connected Solution	Model #	Protocol	Compatible Networks*	Occupancy	Daylight	Temperature Reporting	Communication to Luminaire	Drivers
Acuity nLight (NLT1)	nEPS-60-IO**	nLight	nLight	Enabled	Enabled	No	Wired	**eldoLED ECOdrive,** eldoLED SOLOdrive
Crestron (L11)	Specified Driver	0-10V	Crestron Zūm Wireless & SpaceBuilder	Enabled	Enabled	No	Wired	**Advance by Signify**
Enlighted Smart Sensor (ENL1)	SU-5E-IOT**	Enlighted RF	Enlighted	Integrated	Integrated	Yes	Wireless	**Osram Optotronic,** Advance by Signify
Legrand Wattstopper DLM (DLM1)	LMFC-011**	DLM	DLM	Enabled	Enabled	No	Wired	**Osram Optotronic,** Advance by Signify
Lutron EcoSystem (LH1 & LU5)	LDE1,** LDE5**	EcoSystem	Quantum, Energi Savr Node, Energi TriPak	Enabled	Enabled	No	Wired	**Lutron Hi-Lume Lutron 5-Series**
Osram CLM for ENCELIUM systems (CLM1)	ZBHA-CLM**	ZigBee HA	Osram ENCELIUM & ENCELIUM EDGE	Enabled	Enabled	No	Wireless	**Osram Optotronic**
Osram CLM for ZigBee Wireless Networks (CLMZ1)	ZBHA-CLM**	ZigBee HA	Daintree Networks & open ZigBee Networks	Enabled	Enabled	No	Wireless	**Osram Optotronic**

*Not all compatible networks may be listed. **For performance data and additional control system details please visit the connected solutions manufacturer websites. Primary drivers are listed in **bold.** To specify a particular driver please consult factory. †Controls systems supplied by others.

PARTNERS 21-146A
LUMINAIRE PRODUCT DATA
265700 - 10

L2

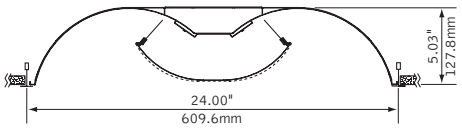
Luna® 2x4

LED

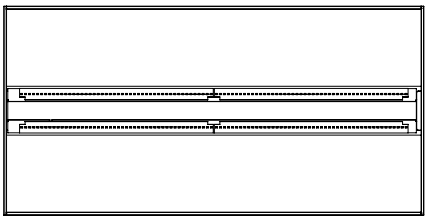
PROVIDE SPECIFIED FIXTURE FOCAL POINT LUNA 2X4, METALUX 24RDI, ORACLE 24-OD-LED, OR ENGINEER APPROVED EQUAL.

FOCAL POINT

DIMENSIONAL DATA



Overall height of ST luminaire is 5.5"



4 LED boards

FEATURES

Architectural recessed LED luminaire with perforated center basket.

Classic style updated with the latest technology.

Reflector and end caps form seamless one-piece housing.

High reflectance, low gloss Matte White finish controls glare.

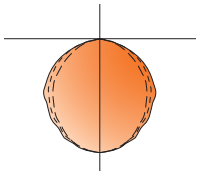
Comparable output to fluorescent versions with reduced wattage.

Luna® LED provides high angle uniform distribution ideal for comfortable general illumination.

Connected Solutions: Integrates with wired and wireless building lighting control systems.

Preferred Light: Lighting for better color rendition and human preference.

PERFORMANCE



Delivered Lumens: 5000lm

Total System Watts: 56W

PRODUCT OVERVIEW

Lumen Output:	3000-7000lm
Wattage:	30-83W
LPW:	83-101
SDCM:	3

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

JUNE 13, 2023 / BIDDING - CONSTRUCTION

fixture: project:

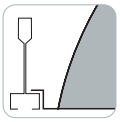
L2

MOUNTING INFORMATION

grid

specify "G" for flat 9/16" and 15/16" tee or "ST" for 9/16" slot tee grid types.

"G" flat tee

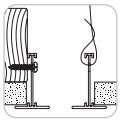


"ST" slot tee

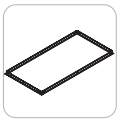
Overall height for ST luminaire is 5.50".

drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.



cut out dimensions:
2': Min: 24.25"
Max: 24.563"
4': Min: 48.25"
Max: 48.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with CRI>80 or CRI>90. 0-10V dimming driver standard. LED modules and drivers are replaceable.

Construction

One-piece 20 Ga. steel reflector and housing. 20 Ga. steel ends form finished housing. LEDs are shielded by detachable 22 Ga. steel perforated shield with acrylic lens insert. LED shield is secured by four spring–pins allowing shield to hinge down for maintenance. Top access 20 Ga. steel driver compartment. Weight: 29 lbs.

Optic

One-piece 20 Ga. steel reflectors finished in Matte Satin White powder coat.

Electrical

Standard 120-277V driver includes 0-10V analog dimming, dimming range 100% - 10% Power factor > .9.

Emergency

Emergency battery output—10 watts for 90 minutes. High Output emergency battery—20 watts for 90 minutes (U.S. only). Emergency Circuit with Connected Solutions (NLT1, ENL1, CLM1, CLMZ1, DLM1) requires a UL924 compliant device, consult factory.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre–treatment. Optional Anti-Microbial paint finish available.

Lumen Maintenance

Reported: L70 > 60,000 hours
L80 > 60,000 hours

Calculated: L70 at > 124,000 hours
L80 at > 78,000 hours

(Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.)

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Lifetime and warranty

LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Lumen Output	Tested System Watts	LPW	Lumen Output	Tested System Watts	LPW
3000	30	101	5500	61	91
3500	35	100	6000	68	88
4000	43	95	6500	76	85
4500	48	94	7000	83	83
5000	56	92			

Based on 3500K, 80 CRI. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

ORDERING

Luminaire Series		**FLUL**
Luna LED	FLUL	
Nominal Size		**24**
2' x 4'	24	
Shielding		**PS**
Perforated Shield	PS	
Lumen Output		
3000 Lumens*	3000L	
3500 Lumens*	3500L	
4000 Lumens	4000L	
4500 Lumens	4500L	
5000 Lumens	5000L	
5500 Lumens	5500L	
6000 Lumens*	6000L	
6500 Lumens*	6500L	
7000 Lumens* (*LD1 & L11 only)	7000L	
Color Temperature		
2700K, 80+ CRI **or** 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 90+ CRI	40K **or** 940K	
3500K, Preferred Light	P35K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
UNV 120/277 Volt	UNV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
Lutron 5-Series EcoSystem (LDE5) - 5% Dimming	LU5	
Acuity nLight - 1% Dimming (Not available with CP)	NLT1	
Enlighted Smart Sensor - 1% Dimming	ENL1	
Osram Connected Lighting Module for ENCELIUM systems - 1% Dimming (Compatible with Osram ENCELIUM and ENCELIUM EDGE systems only)	CLM1	
Osram Connected Lighting Module for ZigBee Wireless Networks - 1% Dimming (Not compatible with Osram ENCELIUM systems)	CLMZ1	
Wattstopper DLM - 1% Dimming	DLM1	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
Drywall Frame Kit (LD1, L11, LH1 & LU5 only) (Cut out dimensions: Min: 24.25"/Max: 24.563" Min: 48.25"/Max: 48.563")	F	
Grid	G	
Slot Tee	ST	
Surface Mount (Not available with DLM1 or NLT1)	SM	
Factory Options		
Air Return (Adds 0.875" to overall height)	AR	
Chicago Plenum	CP	
Emergency Battery (Adds 3.25" to overall height)	B310	
High Output Emergency Battery (Adds 3.25" to overall height. U.S. Only)	B20	
Positional Clip	EQ	
6' New York City Flex Whip (120V)	FNY1	
6' New York City Flex Whip (277V)	FNY2	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White Anti–Microbial	WHA	

PROVIDE EMERGENCY BATTERY FOR FIXTURES LABELLED EM.

QS 5/10 DAY Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

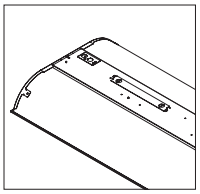
For more information visit focalpointlights.com/reference or consult factory.

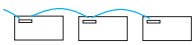
L2

CONNECTED SOLUTIONS

Luna® 2x4 LED

Focal Point provides flexibility in meeting the needs of each project by integrating with several building lighting control systems. A variety of sensors, drivers and other components can be specified that allow the luminaires to communicate with wired and wireless networks. All zoning can be digitally reconfigured through the application software. Daylight harvesting, occupancy sensing, integration with HVAC systems, and individual controls enable the monitoring and modulating of light levels and temperature in order to save energy, reduce costs and maximize occupants' comfort. All Connected Solutions luminaires require a compatible building control system.†





nLIGHT

nLight® provides a two-way wired digital lighting system allowing for on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting.

Acuity nLight - 1% Dimming (NLT1)
Acuity Model #nEPS-60-IO

CAT-5 Cable provided by others.Serial labels will be provided on outside of luminaires and control unit.

enlighted
A Siemens Company

Enlighted smart sensor allows for occupancy sensing, daylight harvesting, energy usage, temperature and light level control. Communicates wirelessly with the Enlighted network.

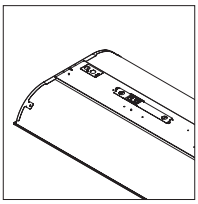
Enlighted Smart Sensor - 1% Dimming (ENL1)
Enlighted Model #SU-5E-IOT

OSRAM

Connected Lighting Module (CLM) enables each luminaire to be independently controlled and configured. Communicates wirelessly with Daintree Networks®, Osram ENCELIUM®, Osram ENCELIUM EDGE™, and other networks using the ZigBee® HA communication protocol to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Osram CLM - 1% Dimming (CLM1 & CLMZ1)
Osram Model #ZBHA-CLM DIM

Serial labels will be provided on outside of luminaires and control unit.

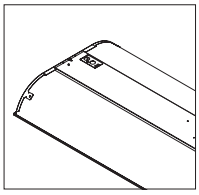


legrand® WATTSTOPPER®

A Digital Lighting Management (DLM) system that provides two-way wired communication between networked luminaires and control system to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Wattstopper DLM - 1% Dimming (DLM1)
Wattstopper Model #LMFC-011

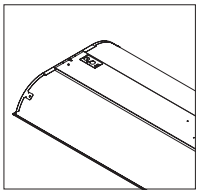
CAT-5 Cable provided by others. Serial labels will be provided on outside of luminaires and control unit.



LUTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting working with Quantum®, Energi Savr Node™, and Energi TriPak® using EcoSystem® communication protocol.

Lutron Hi-Lume EcoSystem - 1% Dimming (LH1)
Lutron Model #LDE1
Lutron 5-Series EcoSystem - 5% Dimming (LU5)
Lutron Model #LDE5



CRESTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting. Communicates with Zūm wireless and SpaceBuilder working with Zūm hub scheduling or FUSION management.

0-10V - 1% Dimming (L11)
Note: 0-10V is not a digital network but is compatible with Creston Zūm™ system.

CONNECTED SOLUTIONS DETAILS

Connected Solution	Model #	Protocol	Compatible Networks*	Occupancy	Daylight	Temperature Reporting	Communication to Luminaire	Drivers
Acuity nLight (NLT1)	nEPS-60-IO**	nLight	nLight	Enabled	Enabled	No	Wired	**eldoLED ECOdrive,** eldoLED SOLOdrive
Crestron (L11)	Specified Driver	0-10V	Crestron Zūm Wireless & SpaceBuilder	Enabled	Enabled	No	Wired	**Advance by Signify**
Enlighted Smart Sensor (ENL1)	SU-5E-IOT**	Enlighted RF	Enlighted	Integrated	Integrated	Yes	Wireless	**Osram Optotronic**, Advance by Signify
Legrand Wattstopper DLM (DLM1)	LMFC-011**	DLM	DLM	Enabled	Enabled	No	Wired	**Osram Optotronic**, Advance by Signify
Lutron EcoSystem (LH1 & LU5)	LDE1;** LDE5**	EcoSystem	Quantum, Energi Savr Node, Energi TriPak	Enabled	Enabled	No	Wired	**Lutron Hi-Lume Lutron 5-Series**
Osram CLM for ENCELIUM systems (CLM1)	ZBHA-CLM**	ZigBee HA	Osram ENCELIUM & ENCELIUM EDGE	Enabled	Enabled	No	Wireless	**Osram Optotronic**
Osram CLM for ZigBee Wireless Networks (CLMZ1)	ZBHA-CLM**	ZigBee HA	Daintree Networks & open ZigBee Networks	Enabled	Enabled	No	Wireless	**Osram Optotronic**

*Not all compatible networks may be listed. **For performance data and additional control system details please visit the connected solutions manufacturer websites. Primary drivers are listed in **bold.** To specify a particular driver please consult factory. †Controls systems supplied by others.

L2A

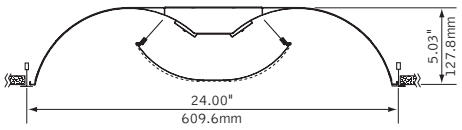
Luna® 2x4

LED

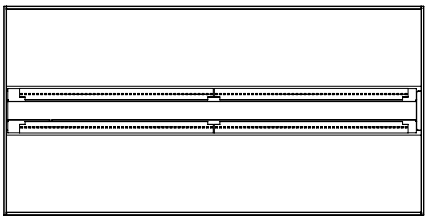
PROVIDE SPECIFIED FIXTURE FOCAL POINT LUNA 2X4, METALUX 24RDI, ORACLE 24-OD-LED, OR ENGINEER APPROVED EQUAL.

FOCAL POINT

DIMENSIONAL DATA



Overall height of ST luminaire is 5.5"



4 LED boards

FEATURES

Architectural recessed LED luminaire with perforated center basket.

Classic style updated with the latest technology.

Reflector and end caps form seamless one-piece housing.

High reflectance, low gloss Matte White finish controls glare.

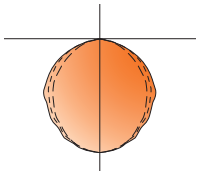
Comparable output to fluorescent versions with reduced wattage.

Luna® LED provides high angle uniform distribution ideal for comfortable general illumination.

Connected Solutions: Integrates with wired and wireless building lighting control systems.

Preferred Light: Lighting for better color rendition and human preference.

PERFORMANCE



Delivered Lumens: 5000lm

Total System Watts: 56W

PRODUCT OVERVIEW

Lumen Output:	3000-7000lm
Wattage:	30-83W
LPW:	83-101
SDCM:	3

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

fixture: project:

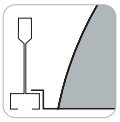
L2A

MOUNTING INFORMATION

grid

specify "G" for flat 9/16" and 15/16" tee or "ST" for 9/16" slot tee grid types.

"G" flat tee

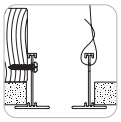


"ST" slot tee

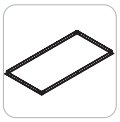
Overall height for ST luminaire is 5.50".

drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.



cut out dimensions:
2': Min: 24.25"
Max: 24.563"
4': Min: 48.25"
Max: 48.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with CRI>80 or CRI>90. 0-10V dimming driver standard. LED modules and drivers are replaceable.

Construction

One-piece 20 Ga. steel reflector and housing. 20 Ga. steel ends form finished housing. LEDs are shielded by detachable 22 Ga. steel perforated shield with acrylic lens insert. LED shield is secured by four spring–pins allowing shield to hinge down for maintenance. Top access 20 Ga. steel driver compartment. Weight: 29 lbs.

Optic

One-piece 20 Ga. steel reflectors finished in Matte Satin White powder coat.

Electrical

Standard 120-277V driver includes 0-10V analog dimming, dimming range 100% - 10% Power factor > .9.

CONTRACTOR TO DETERMINE EXACT MOUNTING METHOD - REFER TO ARCHITECTURAL REFLECTED CEILING PLAN

Emergency

Emergency battery output—10 watts for 90 minutes. High Output emergency battery—20 watts for 90 minutes (U.S. only). Emergency Circuit with Connected Solutions (NLT1, ENL1, CLM1, CLMZ1, DLM1) requires a UL924 compliant device, consult factory.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre–treatment. Optional Anti-Microbial paint finish available.

Lumen Maintenance

Reported: L70 > 60,000 hours
L80 > 60,000 hours

Calculated: L70 at > 124,000 hours
L80 at > 78,000 hours

(Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.)

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Lifetime and warranty

LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Lumen Output	Tested System Watts	LPW
3000	30	101
3500	35	100
4000	43	95
4500	48	94
5000	56	92

Lumen Output	Tested System Watts	LPW
5500	61	91
6000	68	88
6500	76	85
7000	83	83

Based on 3500K, 80 CRI. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

ORDERING

Luminaire Series		**FLUL**
Luna LED	FLUL	
Nominal Size		**24**
2' x 4'	24	
Shielding		**PS**
Perforated Shield	PS	
Lumen Output		
3000 Lumens*	3000L	
3500 Lumens*	3500L	
4000 Lumens	4000L	
4500 Lumens	4500L	
5000 Lumens	5000L	
5500 Lumens	5500L	
6000 Lumens*	6000L	
6500 Lumens*	6500L	
7000 Lumens* (*LD1 & L11 only)	7000L	
Color Temperature		
2700K, 80+ CRI **or** 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 90+ CRI	40K **or** 940K	
3500K, Preferred Light	P35K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
UNV 120/277 Volt	UNV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
Lutron 5-Series EcoSystem (LDE5) - 5% Dimming	LU5	
Acuity nLight - 1% Dimming (Not available with CP)	NLT1	
Enlighted Smart Sensor - 1% Dimming	ENL1	
Osram Connected Lighting Module for ENCELIUM systems - 1% Dimming (Compatible with Osram ENCELIUM and ENCELIUM EDGE systems only)	CLM1	
Osram Connected Lighting Module for ZigBee Wireless Networks - 1% Dimming (Not compatible with Osram ENCELIUM systems)	CLMZ1	
Wattstopper DLM - 1% Dimming	DLM1	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
Drywall Frame Kit (LD1, L11, LH1 & LU5 only) (Cut out dimensions: Min: 24.25"/Max: 24.563" Min: 48.25"/Max: 48.563")	F	
Grid	G	
Slot Tee	ST	
Surface Mount (Not available with DLM1 or NLT1)	SM	
Factory Options		
Air Return (Adds 0.875" to overall height)	AR	
Chicago Plenum	CP	
Emergency Battery (Adds 3.25" to overall height)	B310	
High Output Emergency Battery (Adds 3.25" to overall height. U.S. Only)	B20	
Positional Clip	EQ	
6' New York City Flex Whip (120V)	FNY1	
6' New York City Flex Whip (277V)	FNY2	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White Anti–Microbial	WHA	

PROVIDE EMERGENCY BATTERY FOR FIXTURES LABELLED EM.

QS 5/10 DAY Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

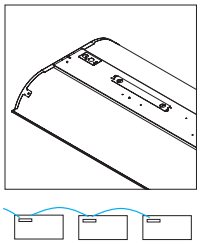
For more information visit focalpointlights.com/reference or consult factory.

L2A

CONNECTED SOLUTIONS

Luna® 2x4 LED

Focal Point provides flexibility in meeting the needs of each project by integrating with several building lighting control systems. A variety of sensors, drivers and other components can be specified that allow the luminaires to communicate with wired and wireless networks. All zoning can be digitally reconfigured through the application software. Daylight harvesting, occupancy sensing, integration with HVAC systems, and individual controls enable the monitoring and modulating of light levels and temperature in order to save energy, reduce costs and maximize occupants' comfort. All Connected Solutions luminaires require a compatible building control system.†



nLIGHT

nLight® provides a two-way wired digital lighting system allowing for on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting.

Acuity nLight - 1% Dimming (NLT1)
Acuity Model #nEPS-60-IO

CAT-5 Cable provided by others.Serial labels will be provided on outside of luminaires and control unit.

enlighted
A Siemens Company

Enlighted smart sensor allows for occupancy sensing, daylight harvesting, energy usage, temperature and light level control. Communicates wirelessly with the Enlighted network.

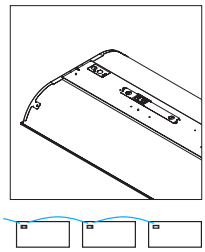
Enlighted Smart Sensor - 1% Dimming (ENL1)
Enlighted Model #SU-5E-IOT

OSRAM

Connected Lighting Module (CLM) enables each luminaire to be independently controlled and configured. Communicates wirelessly with Daintree Networks®, Osram ENCELIUM®, Osram ENCELIUM EDGE™, and other networks using the ZigBee® HA communication protocol to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Osram CLM - 1% Dimming (CLM1 & CLMZ1)
Osram Model #ZBHA-CLM DIM

Serial labels will be provided on outside of luminaires and control unit.

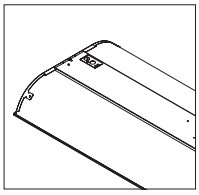


legrand® WATTSTOPPER®

A Digital Lighting Management (DLM) system that provides two-way wired communication between networked luminaires and control system to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Wattstopper DLM - 1% Dimming (DLM1)
Wattstopper Model #LMFC-011

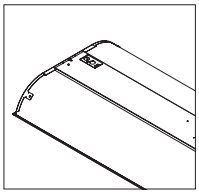
CAT-5 Cable provided by others. Serial labels will be provided on outside of luminaires and control unit.



LUTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting working with Quantum®, Energi Savr Node™, and Energi TriPak® using EcoSystem® communication protocol.

Lutron Hi-Lume EcoSystem - 1% Dimming (LH1)
Lutron Model #LDE1
Lutron 5-Series EcoSystem - 5% Dimming (LU5)
Lutron Model #LDE5



CRESTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting. Communicates with Zūm wireless and SpaceBuilder working with Zūm hub scheduling or FUSION management.

0-10V - 1% Dimming (L11)
Note: 0-10V is not a digital network but is compatible with Creston Zūm™ system.

CONNECTED SOLUTIONS DETAILS

Connected Solution	Model #	Protocol	Compatible Networks*	Occupancy	Daylight	Temperature Reporting	Communication to Luminaire	Drivers
Acuity nLight (NLT1)	nEPS-60-IO**	nLight	nLight	Enabled	Enabled	No	Wired	**eldoLED ECOdrive,** eldoLED SOLOdrive
Crestron (L11)	Specified Driver	0-10V	Crestron Zūm Wireless & SpaceBuilder	Enabled	Enabled	No	Wired	**Advance by Signify**
Enlighted Smart Sensor (ENL1)	SU-5E-IOT**	Enlighted RF	Enlighted	Integrated	Integrated	Yes	Wireless	**Osram Optotronic**, Advance by Signify
Legrand Wattstopper DLM (DLM1)	LMFC-011**	DLM	DLM	Enabled	Enabled	No	Wired	**Osram Optotronic**, Advance by Signify
Lutron EcoSystem (LH1 & LU5)	LDE1;** LDE5**	EcoSystem	Quantum, Energi Savr Node, Energi TriPak	Enabled	Enabled	No	Wired	**Lutron Hi-Lume Lutron 5-Series**
Osram CLM for ENCELIUM systems (CLM1)	ZBHA-CLM**	ZigBee HA	Osram ENCELIUM & ENCELIUM EDGE	Enabled	Enabled	No	Wireless	**Osram Optotronic**
Osram CLM for ZigBee Wireless Networks (CLMZ1)	ZBHA-CLM**	ZigBee HA	Daintree Networks & open ZigBee Networks	Enabled	Enabled	No	Wireless	**Osram Optotronic**

*Not all compatible networks may be listed. **For performance data and additional control system details please visit the connected solutions manufacturer websites. Primary drivers are listed in **bold.** To specify a particular driver please consult factory. †Controls systems supplied by others.

PARTNERS 21-146A
LUMINAIRE PRODUCT DATA
265700 - 16

L2B

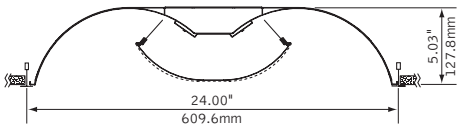
Luna® 2x4

LED

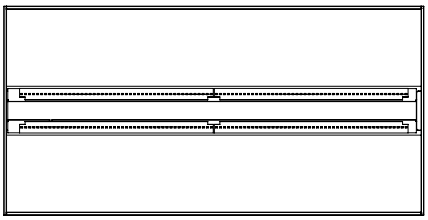
PROVIDE SPECIFIED FIXTURE FOCAL POINT LUNA 2X4, METALUX 24RDI, ORACLE 24-OD-LED, OR ENGINEER APPROVED EQUAL.

FOCAL POINT

DIMENSIONAL DATA



Overall height of ST luminaire is 5.5"



4 LED boards

FEATURES

Architectural recessed LED luminaire with perforated center basket.

Classic style updated with the latest technology.

Reflector and end caps form seamless one-piece housing.

High reflectance, low gloss Matte White finish controls glare.

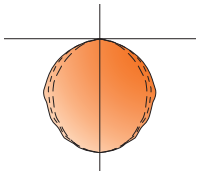
Comparable output to fluorescent versions with reduced wattage.

Luna® LED provides high angle uniform distribution ideal for comfortable general illumination.

Connected Solutions: Integrates with wired and wireless building lighting control systems.

Preferred Light: Lighting for better color rendition and human preference.

PERFORMANCE



Delivered Lumens: 5000lm

Total System Watts: 56W

PRODUCT OVERVIEW

Lumen Output:	3000-7000lm
Wattage:	30-83W
LPW:	83-101
SDCM:	3

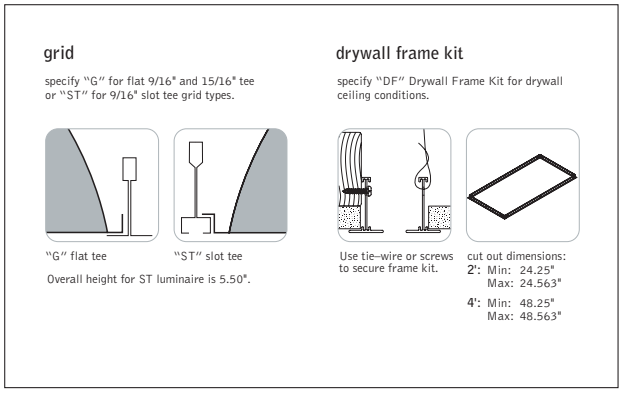
Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

JUNE 13, 2023 / BIDDING - CONSTRUCTION

fixture: project:

L2B

MOUNTING INFORMATION



SPECIFICATIONS

LED System
Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with CRI>80 or CRI>90. 0-10V dimming driver standard. LED modules and drivers are replaceable.

Construction
One-piece 20 Ga. steel reflector and housing. 20 Ga. steel ends form finished housing. LEDs are shielded by detachable 22 Ga. steel perforated shield with acrylic lens insert. LED shield is secured by four spring–pins allowing shield to hinge down for maintenance. Top access 20 Ga. steel driver compartment. Weight: 29 lbs.

Optic
One-piece 20 Ga. steel reflectors finished in Matte Satin White powder coat.

Electrical
Standard 120-277V driver includes 0-10V analog dimming, dimming range 100% - 10% Power factor > .9.

Emergency
Emergency battery output—10 watts for 90 minutes. High Output emergency battery—20 watts for 90 minutes (U.S. only). Emergency Circuit with Connected Solutions (NLT1, ENL1, CLM1, CLMZ1, DLM1) requires a UL924 compliant device, consult factory.

Labels
UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

CONTRACTOR TO DETERMINE EXACT MOUNTING METHOD - REFER TO ARCHITECTURAL REFLECTED CEILING PLAN

Finish
Polyester powder coat applied over a multi-stage pre–treatment. Optional Anti-Microbial paint finish available.

Lumen Maintenance
Reported: L70 > 60,000 hours
L80 > 60,000 hours
Calculated: L70 at > 124,000 hours
L80 at > 78,000 hours
(Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.)

Reliability
At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Lifetime and warranty
LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Lumen Output	Tested System Watts	LPW	Lumen Output	Tested System Watts	LPW
3000	30	101	5500	61	91
3500	35	100	6000	68	88
4000	43	95	6500	76	85
4500	48	94	7000	83	83
5000	56	92			

Based on 3500K, 80 CRI. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

Focal Point LLC reserves the right to change specifications for product improvement without notification.

ORDERING

Luminaire Series		**FLUL**
Luna LED	FLUL	
Nominal Size		**24**
2' x 4'	24	
Shielding		**PS**
Perforated Shield	PS	
Lumen Output		
3000 Lumens*	3000L	
3500 Lumens*	3500L	
4000 Lumens	4000L	
4500 Lumens	4500L	
5000 Lumens	5000L	
5500 Lumens	5500L	
6000 Lumens*	6000L	
6500 Lumens*	6500L	
7000 Lumens* (*LD1 & L11 only)	7000L	
Color Temperature		
2700K, 80+ CRI **or** 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 90+ CRI	40K **or** 940K	
3500K, Preferred Light	P35K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
UNV 120/277 Volt	UNV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
Lutron 5-Series EcoSystem (LDE5) - 5% Dimming	LU5	
Acuity nLight - 1% Dimming (Not available with CP)	NLT1	
Enlighted Smart Sensor - 1% Dimming	ENL1	
Osram Connected Lighting Module for ENCELIUM systems - 1% Dimming (Compatible with Osram ENCELIUM and ENCELIUM EDGE systems only)	CLM1	
Osram Connected Lighting Module for ZigBee Wireless Networks - 1% Dimming (Not compatible with Osram ENCELIUM systems)	CLMZ1	
Wattstopper DLM - 1% Dimming	DLM1	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
Drywall Frame Kit (LD1, L11, LH1 & LU5 only) (Cut out dimensions: Min: 24.25"/Max: 24.563" Min: 48.25"/Max: 48.563")	F	
Grid	G	
Slot Tee	ST	
Surface Mount (Not available with DLM1 or NLT1)	SM	
Factory Options		
Air Return (Adds 0.875" to overall height)	AR	
Chicago Plenum	CP	
Emergency Battery (Adds 3.25" to overall height)	B310	
High Output Emergency Battery (Adds 3.25" to overall height. U.S. Only)	B20	
Positional Clip	EQ	
6' New York City Flex Whip (120V)	FNY1	
6' New York City Flex Whip (277V)	FNY2	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White Anti–Microbial	WHA	

PROVIDE EMERGENCY BATTERY FOR FIXTURES LABELLED EM.

QS 5/10 DAY Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

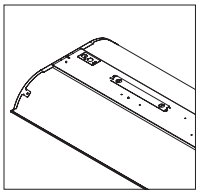
For more information visit focalpointlights.com/reference or consult factory.

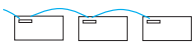
L2B

CONNECTED SOLUTIONS

Luna® 2x4 LED

Focal Point provides flexibility in meeting the needs of each project by integrating with several building lighting control systems. A variety of sensors, drivers and other components can be specified that allow the luminaires to communicate with wired and wireless networks. All zoning can be digitally reconfigured through the application software. Daylight harvesting, occupancy sensing, integration with HVAC systems, and individual controls enable the monitoring and modulating of light levels and temperature in order to save energy, reduce costs and maximize occupants' comfort. All Connected Solutions luminaires require a compatible building control system.†





nLIGHT

nLight® provides a two-way wired digital lighting system allowing for on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting.

Acuity nLight - 1% Dimming (NLT1)
Acuity Model #nEPS-60-IO

CAT-5 Cable provided by others.Serial labels will be provided on outside of luminaires and control unit.

enlighted
A Siemens Company

Enlighted smart sensor allows for occupancy sensing, daylight harvesting, energy usage, temperature and light level control. Communicates wirelessly with the Enlighted network.

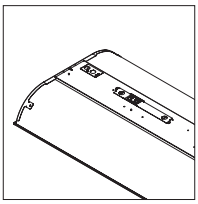
Enlighted Smart Sensor - 1% Dimming (ENL1)
Enlighted Model #SU-5E-IOT

OSRAM

Connected Lighting Module (CLM) enables each luminaire to be independently controlled and configured. Communicates wirelessly with Daintree Networks®, Osram ENCELIUM®, Osram ENCELIUM EDGE™, and other networks using the ZigBee® HA communication protocol to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Osram CLM - 1% Dimming (CLM1 & CLMZ1)
Osram Model #ZBHA-CLM DIM

Serial labels will be provided on outside of luminaires and control unit.

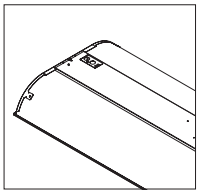


legrand® WATTSTOPPER®

A Digital Lighting Management (DLM) system that provides two-way wired communication between networked luminaires and control system to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Wattstopper DLM - 1% Dimming (DLM1)
Wattstopper Model #LMFC-011

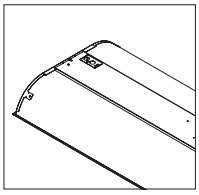
CAT-5 Cable provided by others. Serial labels will be provided on outside of luminaires and control unit.



LUTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting working with Quantum®, Energi Savr Node™, and Energi TriPak® using EcoSystem® communication protocol.

Lutron Hi-Lume EcoSystem - 1% Dimming (LH1)
Lutron Model #LDE1
Lutron 5-Series EcoSystem - 5% Dimming (LU5)
Lutron Model #LDE5



CRESTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting. Communicates with Zūm wireless and SpaceBuilder working with Zūm hub scheduling or FUSION management.

0-10V - 1% Dimming (L11)
Note: 0-10V is not a digital network but is compatible with Creston Zūm™ system.

CONNECTED SOLUTIONS DETAILS

Connected Solution	Model #	Protocol	Compatible Networks*	Occupancy	Daylight	Temperature Reporting	Communication to Luminaire	Drivers
Acuity nLight (NLT1)	nEPS-60-IO**	nLight	nLight	Enabled	Enabled	No	Wired	**eldoLED ECOdrive,** eldoLED SOLOdrive
Crestron (L11)	Specified Driver	0-10V	Crestron Zūm Wireless & SpaceBuilder	Enabled	Enabled	No	Wired	**Advance by Signify**
Enlighted Smart Sensor (ENL1)	SU-5E-IOT**	Enlighted RF	Enlighted	Integrated	Integrated	Yes	Wireless	**Osram Optotronic**, Advance by Signify
Legrand Wattstopper DLM (DLM1)	LMFC-011**	DLM	DLM	Enabled	Enabled	No	Wired	**Osram Optotronic**, Advance by Signify
Lutron EcoSystem (LH1 & LU5)	LDE1;** LDE5**	EcoSystem	Quantum, Energi Savr Node, Energi TriPak	Enabled	Enabled	No	Wired	**Lutron Hi-Lume Lutron 5-Series**
Osram CLM for ENCELIUM systems (CLM1)	ZBHA-CLM**	ZigBee HA	Osram ENCELIUM & ENCELIUM EDGE	Enabled	Enabled	No	Wireless	**Osram Optotronic**
Osram CLM for ZigBee Wireless Networks (CLMZ1)	ZBHA-CLM**	ZigBee HA	Daintree Networks & open ZigBee Networks	Enabled	Enabled	No	Wireless	**Osram Optotronic**

*Not all compatible networks may be listed. **For performance data and additional control system details please visit the connected solutions manufacturer websites. Primary drivers are listed in **bold.** To specify a particular driver please consult factory. †Controls systems supplied by others.

Approved Alternate Manufacturers:
COOPER Lighting LD6B

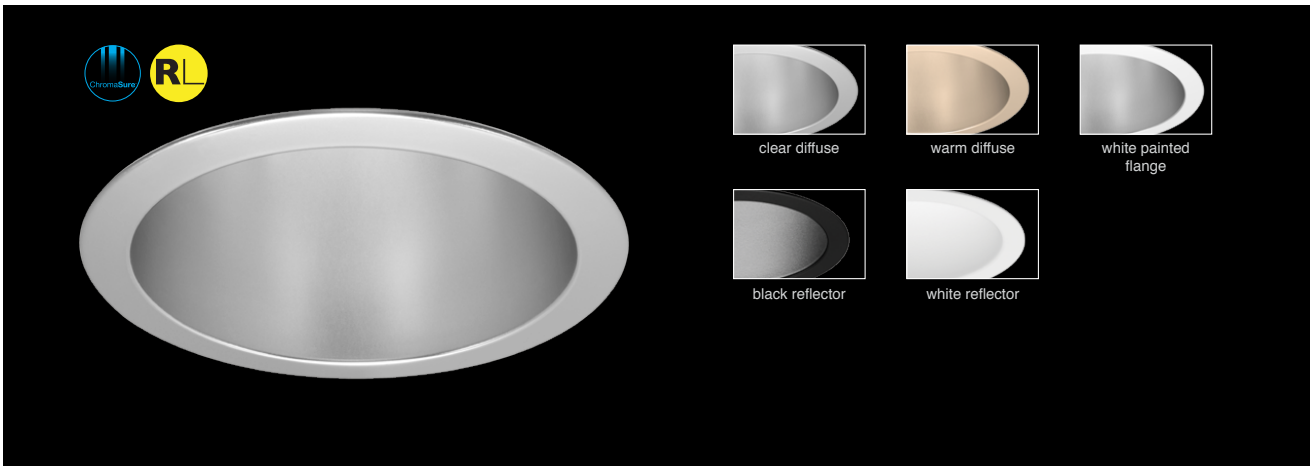
L3

PROVIDE SPECIFIED FIXTURE FOCAL POINT FLC6D, COOPER LD6B, ELITE LED LIGHTING HH6-LED, OR ENGINEER APPROVED EQUAL.

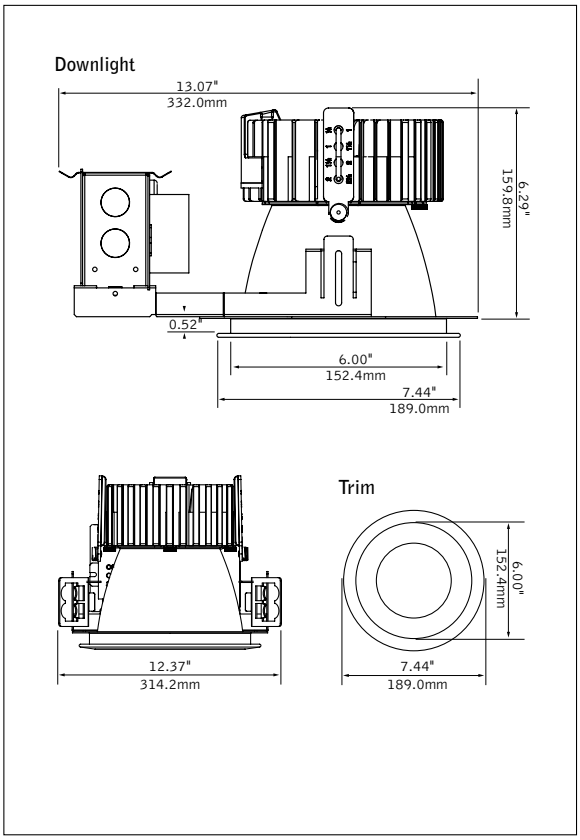
ID+ 6"

LED DOWNLIGHT

FOCAL POINT



DIMENSIONAL DATA



FEATURES

ChromaSure: Color consistency resulting in a 2-step MacAdam ellipse across the entire ID+ product line.

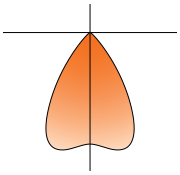
Field adjustability of ceiling thickness from 0.5" - 2.5".

50° cutoff to light source and its image.

Selection of dimming drivers available.

Right Light: Standard delivered lumen outputs 1000, 1500, 2000, 2500 and 3000.

PERFORMANCE



Clear Diffuse Reflector
3500k, 2000 Lumens

Delivered Lumens: 2000lm

Total System Watts: 21W

PRODUCT OVERVIEW

Lumen Output:	1000-3000lm
Wattage:	11-36W
LPW:	83-94
Spacing Criteria:	1.09
SDCM:	2
Lumen Maintenance:	L70 @ 63,000hrs

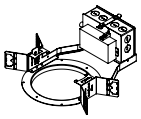
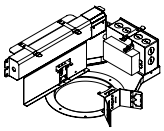
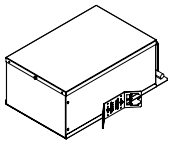
ENERGY STAR

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.Visit energystar.gov for model specifics.

fixture: project:

L3

HOUSING DETAILS

Standard	Emergency Battery	Chicago Plenum
		
L x W x H 13.07″ x 12.37″ x 6.29″	L x W x H 16.21″ x 12.37″ x 6.29″	Standard L x W x H 16.85″ x 11.45″ x 6.53″ Emergency L x W x H 16.85″ x 12.95″ x 6.53″

HOUSING SPECIFICATIONS

Construction

Thermally protected housing for new construction applications. Insulation to be kept 3" away from housing. Butterfly brackets allow mounting to ½ emt. Order bar hangers as an accessory. Die-cast aluminum heat sink designed for maximum thermal dissipation. Die-formed housing and integral junction box with (7) 1⁄2" pry outs. UL & cUL listed for (6) #14 AWG (3 in, 3 out) 90°C conductors and feed through–branch wiring. Accommodates ceiling thicknesses up to 0.5" standard, field adjustable up to 2.5" thickness. For thicker ceiling consult factory. Fixture will not exceed 5 lb.

Electrical

Choice of constant current dimming drivers. Power factor > .9 typical.

Emergency

Emergency Battery Pack: Bodine BSL17C–C2. Emergency output —7W for 90 minutes. Maximum mounting height: 23.3ft. (Black reflector color: 18.1ft.)

Labels

UL and cUL listed. Suitable for Dry or Damp Locations, indoor use only. Specify wet listed (WL) for recessed ceiling applications in indoor and outdoor locations. Lutron Drivers not recommended for outdoor environments below 0°C.

Lumen Maintenance

Reported: L70 at >63,000 hours. Derived from EPA TM-21 calculator

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

PROVIDE EMERGENCY BATTERY PACK WHERE INDICATED

Warranty

LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

TRIM & LED SPECIFICATIONS

LED System

Proprietary array incorporates premium LEDs on a robust platform. May be specified in 2700K, 3000K, 3500K or 4000K, CRI>80. Color accuracy within 2 SDCM. Aluminum heat sink provides appropriate thermal management.

Aesthetics

Parabolic reflector cone ensures glare free optics. Reflector is .050 spun aluminum. Torsion springs pull trim tight to the ceiling with no visible fasteners within the trim. Trims are self-flanged. Non-painted trim matches reflector finish. White painted flange may also be specified.

Optics

50-degree cut–off to light source and its image.

PERFORMANCE CHART

Delivered Lumens	System Watts	LPW
1000	11	88
1500	17	87
2000	21	94
2500	29	85
3000	36	83

*Based on 3000/3500K. Clear Diffuse reflector cone. 80CRI Multipliers: 2700K: 0.94, 4000K: 0.1.06. 90CRI Multipliers: 2700K: 0.71, 3000/3500K: 0.83, 4000K: 0.89. Black Multiplier: 0.56. White Multiplier: 1.13. Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

HOUSING ORDERING

		FLC6D
Housing Series		
ID+ 6" Round Downlight	FLC6D	
Trim Type		
Round Flush	RF	
Round Overlap	RO	
Lumen Output		
1000 Lumens	1000L	
1500 Lumens	1500L	
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
Voltage		
120V	120	
277V**	277	
Driver		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron A-Series - 1% EcoSystem Digital (Consult factory for 3-wire control)	L3D	
Lutron H-Series - 1% Dimming	LH1	
Lutron 5-Series - 5% EcoSystem Digital (Available with 2000L & 2500L)	LU5	
DALI - 1% Dimming (Available with 2500L & 3000L)	D11	
DMX - 3-Channel, 0% Dimming	MZ3	
Housing Type		T
Thermally Protected, Non-IC	T	
Factory Options		
Bar Hangers	BH	
Chicago Plenum / National Plenum	CP	
Emergency Battery (Must order LC6EM trim)	EM	

TRIM & LED MODULE

Aperture		
6" Round Reflector	LC6	
6" Round Reflector - Emergency (Required for "EM" option)	LC6EM	
Trim Type		RD
Round	RD	
Lumen Output (Trim & Housing output must match)		
1000 Lumens	1000L	
1500 Lumens	1500L	
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
Color Temperature		
2700K	27K	
2700K, 90CRI	927K	
3000K	30K	
3000K, 90CRI	930K	
3500K	35K	
3500K, 90CRI	935K	
4000K	40K	
4000K, 90CRI	940K	
Optic		DN
Downlight	DN	
Color		
Clear Diffuse	CD	
Warm Diffuse	WD	
Black (Black Painted flange only)	BK	
White (White Painted flange only)	WH	
Flange Finish		
Non-Painted (Clear and warm diffuse only)	NP	
Black Painted	BP	
White Painted	WP	
Factory Options		
Wet Listed (Not available with 90CRI)	WL	

FINISH/COLOR AS SELECTED BY ARCHITECT.

A complete unit consists of two line items, housing and trim
Example: FLC6D-RO-1500L-120-LD1-T | LC6-RD-1500L-35K-DN-CD-NP

*For more information visit focalpointlights.com/reference or consult factory. **1500 and 2000 lumen outputs add 2 watts to system wattage.

L3

ID+ 6"

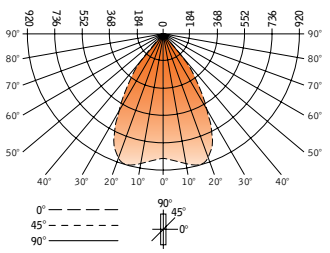
LED DOWNLIGHT

FLC6D-RO-1000L-120-L11-T / LC6-RO-1000L-35K / 40K-DN-CD-NP

Filename: FLC6DRO1000L_35K_40K_DNCD.IES
Test #: 1100924

Lumens: 961lm
System Watts: 11W
LPW: 87

CANDLEPOWER DISTRIBUTION

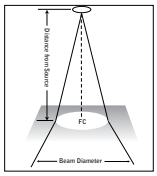


Vertical Angle	Horizontal Angle 0°
0°	836
5°	854
15°	920
25°	762
35°	347
45°	63
55°	7
65°	2
75°	0
85°	0
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	682	71.0
	0-40°	898	93.4
	0-60°	959	99.8
	0-90°	961	100.0
Total Luminaire	0-180°	961	100.0

FOOTCANDLE VALUES



0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.2'	52
6'	7.9'	23
8'	10.5'	13
10'	13.1'	8

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

ID+ 6"

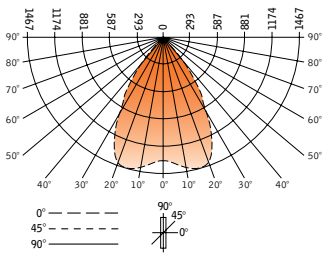
LED DOWNLIGHT

FLC6D-RO-1500L-120-L11-T / LC6-RO-1500L-35K / 40K-DN-CD-NP

Filename: FLC6DRO1500L_35K_40K_DNCD.IES
Test #: 1100922

Lumens: 1548lm
System Watts: 18W
LPW: 86

CANDLEPOWER DISTRIBUTION

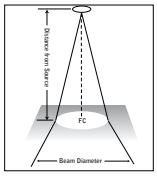


Vertical Angle	Horizontal Angle 0°
0°	1331
5°	1360
15°	1467
25°	1219
35°	558
45°	101
55°	13
65°	4
75°	2
85°	1
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	1090	70.4
	0-40°	1437	92.8
	0-60°	1537	99.3
	0-90°	1545	99.8
Total Luminaire	0-180°	1548	100.0

FOOTCANDLE VALUES



0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.3'	83
6'	7.9'	37
8'	10.6'	21
10'	13.2'	13

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

L3

ID+ 6"

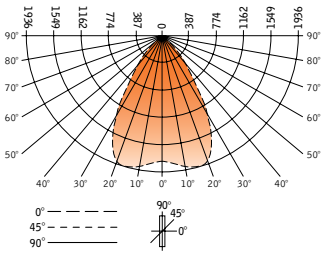
LED DOWNLIGHT

FLC6D-RO-2000L-120-L11-T / LC6-RO-2000L-35K / 40K-DN-CD-NP

Filename: FLC6DRO2000L_35K_40K_DNCD.IES
Test #: 1117169

Lumens: 2058
System Watts: 22W
LPW: 94

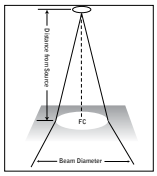
CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°
0°	1785
5°	1823
15°	1936
25°	1624
35°	749
45°	136
55°	18
65°	6
75°	2
85°	0
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	1448	70.4
	0-40°	1913	93.0
	0-60°	2049	99.6
	0-90°	2058	100.0
Total Luminaire	0-180°	2058	100.0



FOOTCANDLE VALUES

0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.3'	112
6'	7.9'	50
8'	10.6'	28
10'	13.2'	18

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

ID+ 6"

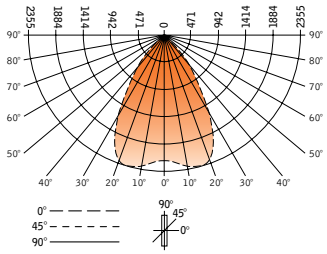
LED DOWNLIGHT

FLC6D-RO-2500L-120-L11-T / LC6-RO-2500L-35K / 40K-DN-CD-NP

Filename: FLC6DRO2500L_35K_40K_DNCD.IES
Test #: 1117167

Lumens: 2500
System Watts: 30W
LPW: 83

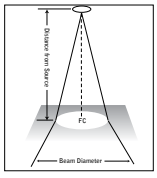
CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°
0°	2169
5°	2216
15°	2355
25°	1973
35°	909
45°	165
55°	21
65°	7
75°	3
85°	1
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	1760	70.4
	0-40°	2325	93.0
	0-60°	2489	99.6
	0-90°	2500	100.0
Total Luminaire	0-180°	2500	100.0



FOOTCANDLE VALUES

0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.3'	136
6'	7.9'	60
8'	10.6'	34
10'	13.2'	22

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

L3

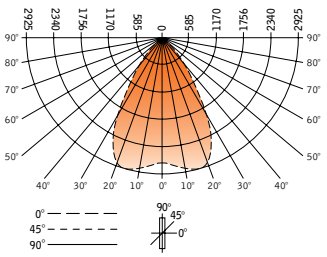
ID+ 6"

LED DOWNLIGHT

FLC6D-RO-3000L-120-L11-T / LC6-RO-3000L-35K / 40K-DN-CD-NP

Filename:	FLC6DRO3000L_35K_40K_DNCD.IES	Lumens:	3104
Test #:	1117168	System Watts:	38W
		LPW:	82

CANDLEPOWER DISTRIBUTION

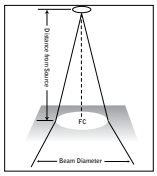


Vertical Angle	Horizontal Angle 0°
0°	2693
5°	2751
15°	2925
25°	2451
35°	1128
45°	205
55°	26
65°	9
75°	3
85°	1
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	2186	70.4
	0-40°	2887	93.0
	0-60°	3091	99.6
	0-90°	3104	100.0
Total Luminaire	0-180°	3104	100.0

FOOTCANDLE VALUES



0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.2'	168
6'	7.9'	75
8'	10.5'	42
10'	13.1'	27

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L4

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T8 lengths. Ideal for use 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 — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install six-point row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), or matte black (MB). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare.

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 3). Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. 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.

LEDs provide 80CRI or 90 CRI at 3000 K, 3500 K,4000 K or 5000 K.

Lumen output up to 1,500 lumens per foot. Luminaire should be installed in applications where ambient temperatures do not exceed 86 °F (30 °C).

INSTALLATION — Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Six-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40 °F (-40 °C) and 86 °F (30 °C).

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.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/resources/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.

Z SERIES

LED Striplight

ZL1D

24", 48" and 96" Lengths

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURERS OR ENGINEER APPROVED EQUAL.

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® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

L4

ZL1D LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1D L48 3000LM FST MVOLT 40K 80CRI WH

Series	Length	Reflectors[1]	Nominal lumens[2]	Diffuser	Voltage	Color temperature
ZL1D LED striplight	L24 24"	(blank) Less reflector	1500LM 1,500 lumens	FST Drop lens	MVOLT 120-277V	30K 3000 K
		SMR Symmetric	2500LM 2,500 lumens		120 120V	35K 3500 K
			3500LM 3,500 lumens		208 208V	40K 4000 K
	L48 48"	(blank) Less reflector	3000LM 3,000 lumens		240 240V	50K 5000 K
		ASR Asymmetric	5000LM 5,000 lumens		277 277V	
		SMR Symmetric	7000LM 7,000 lumens		347 347V[3]	
TZL1D LED striplight	L96 96"	(blank) Less reflector	6000LM 6,000 lumens		480 480V[3]	
		SMR Symmetric	10000LM 10,000 lumens			
			14000LM 14,000 lumens			

FINISH/COLOR AS SELECTED BY ARCHITECT.

Color rendering index	Options		Cord sets:[10]	Paint finish
80CRI 80 CRI	PLR___	Plug-in wiring[4,5]	CS1W Straight plug, 120V	WH White
90CRI 90 CRI	PLR1LVG	Plug-in wiring-low voltage[4,5]	CS3W Twist-lock, 120V	MB Matte black
	E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[6,7]	CS7W Straight plug, 277V	GALVB Galvanized fixture with black plastic lens endcaps
	2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[6,7,8]	CS11W Twist-lock, 277V	GALVW Galvanized fixture with white plastic lens endcaps
	E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7]	CS25W Twist-lock, 347V	
	2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7,8]	CS97W Twist-lock, 480V	
	E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7,8]	CS93W 600V SEOOW white cord, no plug (no voltage required)	
	OUTEND	Cord set to exit endplate of fixture		
	LBOZU	360° low mount motion sensor, pre-wired[9]		
	LBH0SZU	360° low mount motion sensor with dimming, pre-wired[9]		
	LBPZU	360° low mount motion sensor with photocell, pre-wired[9]		
	LBM0SZU	360° low mount motion sensor, dimming & switching photocell, pre-wired[9]		

PROVIDE EMERGENCY BATTERY PACK WHERE INDICATED

OR SURFACE MOUNT AS INDICATED

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[11]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[11,12]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Optional. Reflectors ship separately.
2 See Operational Data on page 2 for actual lumens.
3 Not available with L24, 24" fixture. 347V and 480V utilize a step-down transformer.
4 See ordering information on page 5. When choosing sensor options and and PLR configuration, contact factory representative.
5 Not available with cordsets.
6 Not available with L24, 24" fixture. See spec sheet PS1055LCP, PS1555LCP and PS750L for more information. Emergency battery backup only available from -4 °F (-20 °C) to 86 °F (30 °C)
7 Must specify voltage. 120, 208, 240 or 277V.
8 Only available with the 10,000LM and 14,000LM fixtures.
9 Voltage must be specified. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
10 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
11 Not compatible with reflector.
12 Order 2 for tandem double length fixtures (TZL1D).

L4

ZL1D LED Striplight

OPERATIONAL DATA

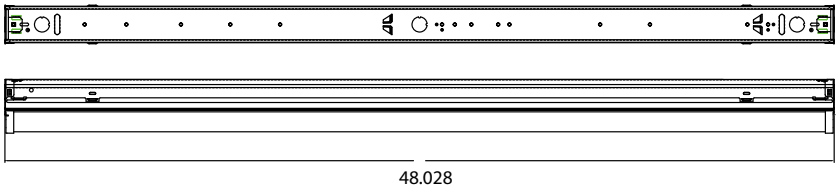
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1985	1619	2030	1675	2061	1707	2137	1745	17	1-lamp 17W T8
	2500LM	24	2682	2187	2742	2264	2785	2307	2887	2358	22	1-lamp 17W T8
	3500LM	24	4099	3341	4190	3459	4255	3524	4412	3603	36	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	48	3880	3163	3966	3274	4028	3336	4176	3410	30	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	48	5337	4351	5456	4504	5541	4589	5745	4691	41	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	48	7317	5965	7480	6175	7596	6291	7876	6431	59	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	96	8077	6585	8257	6816	8386	6945	8694	7099	60	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	96	11021	8985	11267	9301	11442	9477	11864	9687	81	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	96	15397	12553	15741	12995	15986	13240	16574	13534	121	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

DIMENSIONS

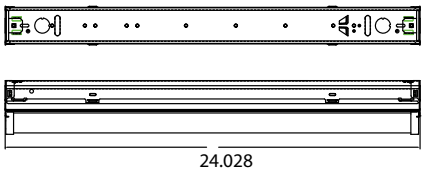
All dimensions are shown in inches (centimeters) unless otherwise noted.
Specifications subject to change without notice.

PALLET DIMENSIONS

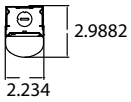
Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	176	46" X 51" X 31 5/8"
L48	13 lbs.	176	46" X 51" X 31 5/8"
L96	26 lbs.	63	46" X 98 1/2" X 31 3/8"



ZL1D L48

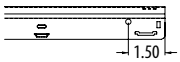


Knockout hole is .86in in diameter.



ZL1D L24

Mounting Hole Location - All Lengths

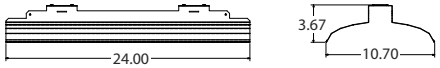


L4

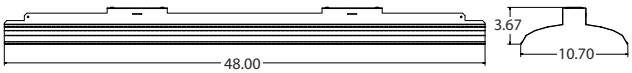
ZL1D LED Striplight

REFLECTORS (Optional)

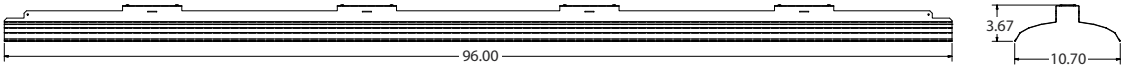
L24 Reflector



L48 Reflector



L96 Reflector



PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. 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.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits				Dimming		Ground	
			Circuits to which ballast is connected		Emergency circuit connected					
PLR	(blank)	Not required for 22	(blank)	Not required for 22	(blank)	No emergency circuit	LV	Low-voltage dimming	G	Ground, required
PLR22	1	Black	A	Black wire	ELA	Emergency circuit wired to black wire				
	2	Black and red	B	Red wire	ELB	Emergency circuit wired to red wire				

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

L4

ZL1D LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LC0ZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LA0ZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION

Example: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Max and min dim levels not applicable with this option.

2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION

Example: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

L4

ZL1D LED Striplight

PRODUCT INFORMATION

A standard occupancy time delay is also present to ensure lights turn off (once minimum on timer has also elapsed) if no occupancy is detected.

This timer is factory set at 10 minutes to promote energy savings, but is adjustable between 30 seconds and 30 minutes. These adjustments may be done through the unit's push-button.

FEATURES

- Four interchangeable lenses - high mount 360°, low mount 360°, high mount aisleway, and small motion 360°.
- Integrated mounting bracket drops lens down 3" from chase nipple - no bracket accessory required.
- 100% digital PIR detection - provides excellent RF immunity

Note: Specifications subject to change without notice.

Passive Infrared Indoor Occupancy Sensor

LSXR

Single Relay

AcuityControls Sensor Switch

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: LSXR 10 ADC HVOLT 30M

LSXR											
Series		**Lens option**						**Dimming/photocell**	
LSXR	Passive Infrared Indoor Occupancy Sensor	(blank)	No lens	610	High and low mount 360°	(blank)	None
		6	High mount, 360°	650	High mount 360° and aisleway	HL	High/low occupancy operation
		10	Low mount, 360°	3PK	High and low mount 360° and aisleway	P	Switching photocell (on/off)
		50	High mount aisleway	4PK	All lenses	ADC	Dimming and switching photocell
		9	Small motion, 360°			ANL	Dimming and switching photocell with high/low occupancy operation

Voltage		**Max dim level**		**Min dim level**		**Lead length**		**Temp humidity**		**Default time delay**	
(blank)	120-277 VAC (MVOLT)	(blank)	10 VDC	(blank)	Minimum dimming level of ballast	(blank)	14"	(blank)	None	(blank)	10 minutes (with minimum 15 minutes on time)
HVOLT	347-480 VAC	9H	9 VDC	1V	1 VDC	42L	42"	LT	Low temperature	5M	5 minutes (LED only)
		8H	8 VDC	2V	2 VDC					15M	15 minutes
		7H	7 VDC	3V	3 VDC					20M	20 minutes
				4V	4 VDC					30M	30 minutes
				5V	5 VDC						
				6V	6 VDC						

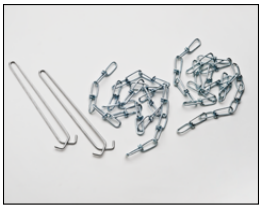
For additional information see www.lithonia.com

L4

ZL1D LED Striplight

OPTIONS AND ACCESSORIE

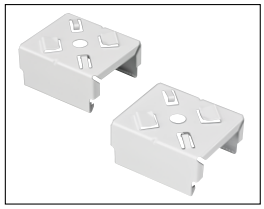
The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.



HANGER CHAIN

36" chain with Y hanger.

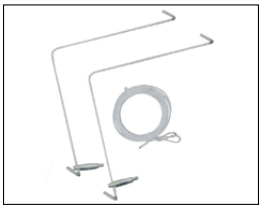
Order as:
HC36



Z SPRING HANGER

Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

Order as:
ZSPRG



ZACVH HANGER

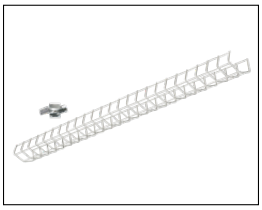
10' Aircraft cable with Y hanger.

Order as:
ZACVH

ANGLE MOUNTING BRACKET

Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-SERV (7378) www.lithonia.com

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L4A

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T8 lengths. Ideal for use 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 — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install six-point row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), or matte black (MB). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare.

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 3). Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. 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.

LEDs provide 80CRI or 90 CRI at 3000 K, 3500 K, 4000 K or 5000 K.

Lumen output up to 1,500 lumens per foot. Luminaire should be installed in applications where ambient temperatures do not exceed 86 °F (30 °C).

INSTALLATION — Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Six-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40 °F (-40 °C) and 86 °F (30 °C).

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.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/resources/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.

Z SERIES

LED Striplight

ZL1D

24", 48" and 96" Lengths

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURERS OR ENGINEER APPROVED EQUAL.

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® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

L4A

ZL1D LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1D L48 3000LM FST MVOLT 40K 80CRI WH

Series	Length	Reflectors[1]	Nominal lumens[2]	Diffuser	Voltage	Color temperature
ZL1D LED striplight	L24 24"	(blank) Less reflector	1500LM 1,500 lumens	FST Drop lens	MVOLT 120-277V	30K 3000 K
		SMR Symmetric	2500LM 2,500 lumens		120 120V	35K 3500 K
			3500LM 3,500 lumens		208 208V	40K 4000 K
	L48 48"	(blank) Less reflector	3000LM 3,000 lumens		240 240V	50K 5000 K
		ASR Asymmetric	5000LM 5,000 lumens		277 277V	
		SMR Symmetric	7000LM 7,000 lumens		347 347V[3]	
TZL1D LED striplight	L96 96"	(blank) Less reflector	6000LM 6,000 lumens		480 480V[3]	
		SMR Symmetric	10000LM 10,000 lumens			
			14000LM 14,000 lumens			

FINISH/COLOR AS SELECTED BY ARCHITECT.

Color rendering index	Options		Paint finish
80CRI 80 CRI	PLR___ Plug-in wiring[4,5]	Cord sets:[10]	WH White
90CRI 90 CRI	PLR1LVG Plug-in wiring-low voltage[4,5]	CS1W Straight plug, 120V	MB Matte black
	E7W Emergency battery pack, 7W CA Title 20 Noncompliant[6,7]	CS3W Twist-lock, 120V	GALVB Galvanized fixture with black plastic lens endcaps
	2E7W Two Emergency battery packs, 7W CA Title 20 Noncompliant[6,7,8]	CS7W Straight plug, 277V	GALVW Galvanized fixture with white plastic lens endcaps
	E10WLCP Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7]	CS11W Twist-lock, 277V	
	2E10WLCP Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7,8]	CS25W Twist-lock, 347V	
	E15WLCP Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7,8]	CS97W Twist-lock, 480V	
	OUTEND Cord set to exit endplate of fixture	CS93W 600V SEOOW white cord, no plug (no voltage required)	
	LBOZU 360° low mount motion sensor, pre-wired[9]		
	LBH0SZU 360° low mount motion sensor with dimming, pre-wired[9]		
	LBPZU 360° low mount motion sensor with photocell, pre-wired[9]		
	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired[9]		

PROVIDE EMERGENCY BATTERY PACK WHERE INDICATED

OR SURFACE MOUNT AS INDICATED

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[11]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[11,12]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Optional. Reflectors ship separately.
2 See Operational Data on page 2 for actual lumens.
3 Not available with L24, 24" fixture. 347V and 480V utilize a step-down transformer.
4 See ordering information on page 5. When choosing sensor options and and PLR configuration, contact factory representative.
5 Not available with cordsets.
6 Not available with L24, 24" fixture. See spec sheet PS1055LCP, PS1555LCP and PS750L for more information. Emergency battery backup only available from -4 °F (-20 °C) to 86 °F (30 °C)
7 Must specify voltage. 120, 208, 240 or 277V.
8 Only available with the 10,000LM and 14,000LM fixtures.
9 Voltage must be specified. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
10 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
11 Not compatible with reflector.
12 Order 2 for tandem double length fixtures (TZL1D).

L4A

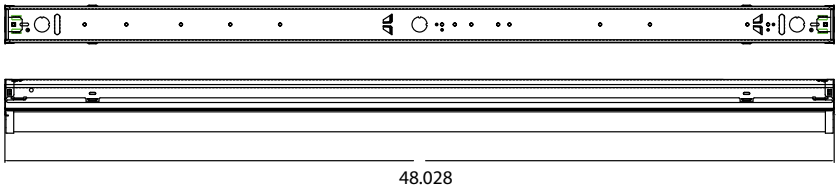
ZL1D LED Striplight

OPERATIONAL DATA												
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1985	1619	2030	1675	2061	1707	2137	1745	17	1-lamp 17W T8
	2500LM	24	2682	2187	2742	2264	2785	2307	2887	2358	22	1-lamp 17W T8
	3500LM	24	4099	3341	4190	3459	4255	3524	4412	3603	36	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	48	3880	3163	3966	3274	4028	3336	4176	3410	30	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	48	5337	4351	5456	4504	5541	4589	5745	4691	41	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	48	7317	5965	7480	6175	7596	6291	7876	6431	59	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	96	8077	6585	8257	6816	8386	6945	8694	7099	60	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	96	11021	8985	11267	9301	11442	9477	11864	9687	81	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	96	15397	12553	15741	12995	15986	13240	16574	13534	121	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

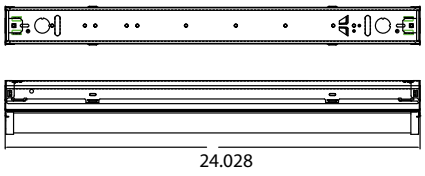
DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.
Specifications subject to change without notice.

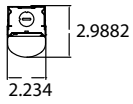
PALLET DIMENSIONS			
Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	176	46" X 51" X 31 5/8"
L48	13 lbs.	176	46" X 51" X 31 5/8"
L96	26 lbs.	63	46" X 98 1/2" X 31 3/8"



ZL1D L48

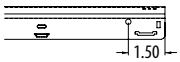


Knockout hole is .86in in diameter.



ZL1D L24

Mounting Hole Location - All Lengths

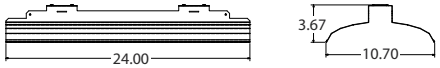


L4A

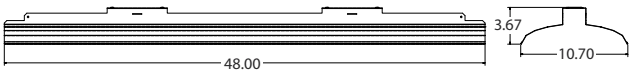
ZL1D LED Striplight

REFLECTORS (Optional)

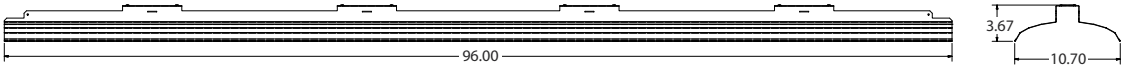
L24 Reflector



L48 Reflector



L96 Reflector



PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. 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.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits				Dimming		Ground	
			Circuits to which ballast is connected		Emergency circuit connected					
PLR	(blank)	Not required for 22	(blank)	Not required for 22	(blank)	No emergency circuit	LV	Low-voltage dimming	G	Ground, required
PLR22	1	Black	A	Black wire	ELA	Emergency circuit wired to black wire				
	2	Black and red	B	Red wire	ELB	Emergency circuit wired to red wire				

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

L4A

ZL1D LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LC0ZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LA0ZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION

Example: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Max and min dim levels not applicable with this option.

2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION

Example: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

L4A

ZL1D LED Striplight

PRODUCT INFORMATION

A standard occupancy time delay is also present to ensure lights turn off (once minimum on timer has also elapsed) if no occupancy is detected.

This timer is factory set at 10 minutes to promote energy savings, but is adjustable between 30 seconds and 30 minutes. These adjustments may be done through the unit's push-button.

FEATURES

- Four interchangeable lenses - high mount 360°, low mount 360°, high mount aisleway, and small motion 360°.
- Integrated mounting bracket drops lens down 3" from chase nipple - no bracket accessory required.
- 100% digital PIR detection - provides excellent RF immunity

Note: Specifications subject to change without notice.

Passive Infrared Indoor Occupancy Sensor

LSXR

Single Relay

AcuityControls. Sensor Switch.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: LSXR 10 ADC HVOLT 30M

LSXR									
Series		**Lens option**					**Dimming/photocell**		
LSXR	Passive Infrared Indoor Occupancy Sensor	(blank)	No lens	610	High and low mount 360°		(blank)	None	
		6	High mount, 360°	650	High mount 360° and aisleway		HL	High/low occupancy operation	
		10	Low mount, 360°	3PK	High and low mount 360° and aisleway		P	Switching photocell (on/off)	
		50	High mount aisleway	4PK	All lenses		ADC	Dimming and switching photocell	
		9	Small motion, 360°				ANL	Dimming and switching photocell with high/low occupancy operation	

Voltage		**Max dim level**		**Min dim level**		**Lead length**		**Temp humidity**		**Default time delay**	
(blank)	120-277 VAC (MVOLT)	(blank)	10 VDC	(blank)	Minimum dimming level of ballast	(blank)	14"	(blank)	None	(blank)	10 minutes (with minimum 15 minutes on time)
HVOLT	347-480 VAC	9H	9 VDC	1V	1 VDC	42L	42"	LT	Low temperature	5M	5 minutes (LED only)
		8H	8 VDC	2V	2 VDC					15M	15 minutes
		7H	7 VDC	3V	3 VDC					20M	20 minutes
				4V	4 VDC					30M	30 minutes
				5V	5 VDC						
				6V	6 VDC						

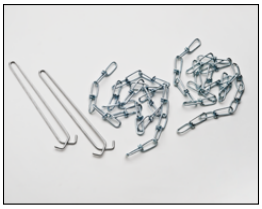
For additional information see www.lithonia.com

L4A

ZL1D LED Striplight

OPTIONS AND ACCESSORIE

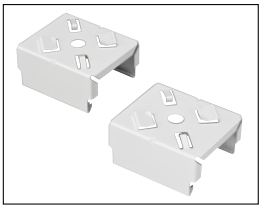
The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.



HANGER CHAIN

36" chain with Y hanger.

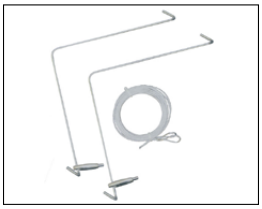
Order as:
HC36



Z SPRING HANGER

Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

Order as:
ZSPRG



ZACVH HANGER

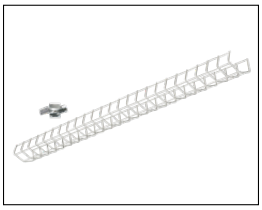
10' Aircraft cable with Y hanger.

Order as:
ZACVH

ANGLE MOUNTING BRACKET

Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L4B

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T8 lengths. Ideal for use 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 — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install six-point row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), or matte black (MB). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare.

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 3). Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. 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.

LEDs provide 80CRI or 90 CRI at 3000 K, 3500 K,4000 K or 5000 K.

Lumen output up to 1,500 lumens per foot. Luminaire should be installed in applications where ambient temperatures do not exceed 86 °F (30 °C).

INSTALLATION — Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Six-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40 °F (-40 °C) and 86 °F (30 °C).

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.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/resources/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.

Z SERIES

LED Striplight

ZL1D

24", 48" and 96" Lengths

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURERS OR ENGINEER APPROVED EQUAL.

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® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

L4B

ZL1D LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1D L48 3000LM FST MVOLT 40K 80CRI WH

Series	Length	Reflectors[1]	Nominal lumens[2]	Diffuser	Voltage	Color temperature
ZL1D LED striplight	L24 24"	(blank) Less reflector	1500LM 1,500 lumens	FST Drop lens	MVOLT 120-277V	30K 3000 K
		SMR Symmetric	2500LM 2,500 lumens		120 120V	35K 3500 K
			3500LM 3,500 lumens		208 208V	40K 4000 K
	L48 48"	(blank) Less reflector	3000LM 3,000 lumens		240 240V	50K 5000 K
		ASR Asymmetric	5000LM 5,000 lumens		277 277V	
		SMR Symmetric	7000LM 7,000 lumens		347 347V[3]	
TZL1D LED striplight	L96 96"	(blank) Less reflector	6000LM 6,000 lumens		480 480V[3]	
		SMR Symmetric	10000LM 10,000 lumens			
			14000LM 14,000 lumens			

FINISH/COLOR AS SELECTED BY ARCHITECT.

Color rendering index	Options		Cord sets:[10]	Paint finish
80CRI 80 CRI	PLR___	Plug-in wiring[4,5]	CS1W Straight plug, 120V	WH White
90CRI 90 CRI	PLR1LVG	Plug-in wiring-low voltage[4,5]	CS3W Twist-lock, 120V	MB Matte black
	E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[6,7]	CS7W Straight plug, 277V	GALVB Galvanized fixture with black plastic lens endcaps
	2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[6,7,8]	CS11W Twist-lock, 277V	GALVW Galvanized fixture with white plastic lens endcaps
	E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7]	CS25W Twist-lock, 347V	
	2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7,8]	CS97W Twist-lock, 480V	
	E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[6,7,8]	CS93W 600V SEOOW white cord, no plug (no voltage required)	
	OUTEND	Cord set to exit endplate of fixture		
	LBOZU	360° low mount motion sensor, pre-wired[9]		
	LBH0SZU	360° low mount motion sensor with dimming, pre-wired[9]		
	LBPZU	360° low mount motion sensor with photocell, pre-wired[9]		
	LBM0SZU	360° low mount motion sensor, dimming & switching photocell, pre-wired[9]		

PROVIDE EMERGENCY BATTERY PACK WHERE INDICATED

OR SURFACE MOUNT AS INDICATED

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[11]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[11,12]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Optional. Reflectors ship separately.
2 See Operational Data on page 2 for actual lumens.
3 Not available with L24, 24" fixture. 347V and 480V utilize a step-down transformer.
4 See ordering information on page 5. When choosing sensor options and and PLR configuration, contact factory representative.
5 Not available with cordsets.
6 Not available with L24, 24" fixture. See spec sheet PS1055LCP, PS1555LCP and PS750L for more information. Emergency battery backup only available from -4 °F (-20 °C) to 86 °F (30 °C)
7 Must specify voltage. 120, 208, 240 or 277V.
8 Only available with the 10,000LM and 14,000LM fixtures.
9 Voltage must be specified. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
10 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
11 Not compatible with reflector.
12 Order 2 for tandem double length fixtures (TZL1D).

L4B

ZL1D LED Striplight

OPERATIONAL DATA

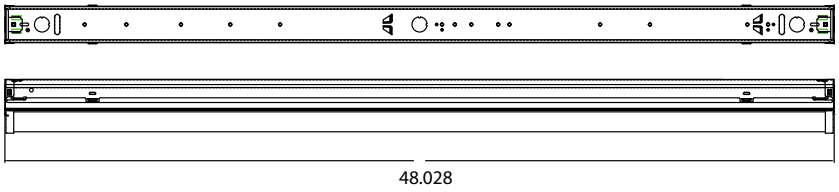
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1985	1619	2030	1675	2061	1707	2137	1745	17	1-lamp 17W T8
	2500LM	24	2682	2187	2742	2264	2785	2307	2887	2358	22	1-lamp 17W T8
	3500LM	24	4099	3341	4190	3459	4255	3524	4412	3603	36	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	48	3880	3163	3966	3274	4028	3336	4176	3410	30	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	48	5337	4351	5456	4504	5541	4589	5745	4691	41	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	48	7317	5965	7480	6175	7596	6291	7876	6431	59	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	96	8077	6585	8257	6816	8386	6945	8694	7099	60	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	96	11021	8985	11267	9301	11442	9477	11864	9687	81	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	96	15397	12553	15741	12995	15986	13240	16574	13534	121	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

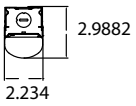
DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.
Specifications subject to change without notice.

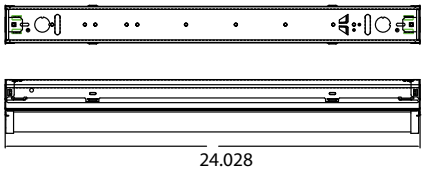
PALLET DIMENSIONS

Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	176	46" X 51" X 31 5/8"
L48	13 lbs.	176	46" X 51" X 31 5/8"
L96	26 lbs.	63	46" X 98 1/2" X 31 3/8"



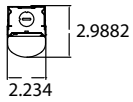


ZL1D L48

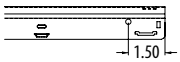


ZL1D L24

Knockout hole is .86in in diameter.



Mounting Hole Location - All Lengths

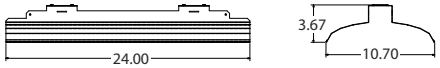


L4B

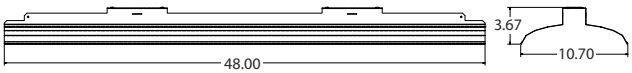
ZL1D LED Striplight

REFLECTORS (Optional)

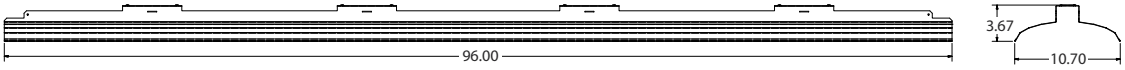
L24 Reflector



L48 Reflector



L96 Reflector



PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. 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.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits				Dimming		Ground	
			Circuits to which ballast is connected		Emergency circuit connected					
PLR	(blank)	Not required for 22	(blank)	Not required for 22	(blank)	No emergency circuit	LV	Low-voltage dimming	G	Ground, required
PLR22	1	Black	A	Black wire	ELA	Emergency circuit wired to black wire				
	2	Black and red	B	Red wire	ELB	Emergency circuit wired to red wire				

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

L4B

ZL1D LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LCOZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LAOZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION

Example: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Max and min dim levels not applicable with this option.

2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION

Example: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

L4B

ZL1D LED Striplight

PRODUCT INFORMATION

A standard occupancy time delay is also present to ensure lights turn off (once minimum on timer has also elapsed) if no occupancy is detected.

This timer is factory set at 10 minutes to promote energy savings, but is adjustable between 30 seconds and 30 minutes. These adjustments may be done through the unit's push-button.

FEATURES

- Four interchangeable lenses - high mount 360°, low mount 360°, high mount aisleway, and small motion 360°.
- Integrated mounting bracket drops lens down 3" from chase nipple - no bracket accessory required.
- 100% digital PIR detection - provides excellent RF immunity

Note: Specifications subject to change without notice.

Passive Infrared Indoor Occupancy Sensor

LSXR

Single Relay

AcuityControls Sensor Switch

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: LSXR 10 ADC HVOLT 30M

LSXR											
Series		**Lens option**						**Dimming/photocell**	
LSXR	Passive Infrared Indoor Occupancy Sensor	(blank)	No lens	610	High and low mount 360°	(blank)	None
		6	High mount, 360°	650	High mount 360° and aisleway	HL	High/low occupancy operation
		10	Low mount, 360°	3PK	High and low mount 360° and aisleway	P	Switching photocell (on/off)
		50	High mount aisleway	4PK	All lenses	ADC	Dimming and switching photocell
		9	Small motion, 360°			ANL	Dimming and switching photocell with high/low occupancy operation

Voltage		**Max dim level**		**Min dim level**		**Lead length**		**Temp humidity**		**Default time delay**	
(blank)	120-277 VAC (MVOLT)	(blank)	10 VDC	(blank)	Minimum dimming level of ballast	(blank)	14"	(blank)	None	(blank)	10 minutes (with minimum 15 minutes on time)
HVOLT	347-480 VAC	9H	9 VDC	1V	1 VDC	42L	42"	LT	Low temperature	5M	5 minutes (LED only)
		8H	8 VDC	2V	2 VDC					15M	15 minutes
		7H	7 VDC	3V	3 VDC					20M	20 minutes
				4V	4 VDC					30M	30 minutes
				5V	5 VDC						
				6V	6 VDC						

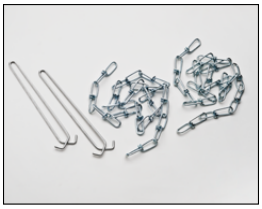
For additional information see www.lithonia.com

L4B

ZL1D LED Striplight

OPTIONS AND ACCESSORIE

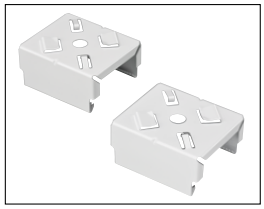
The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.



HANGER CHAIN

36" chain with Y hanger.

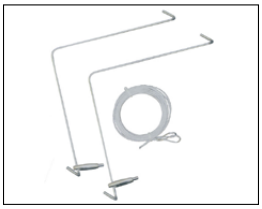
Order as:
HC36



Z SPRING HANGER

Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

Order as:
ZSPRG



ZACVH HANGER

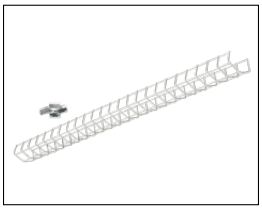
10' Aircraft cable with Y hanger.

Order as:
ZACVH

ANGLE MOUNTING BRACKET

Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-SERV (7378) www.lithonia.com

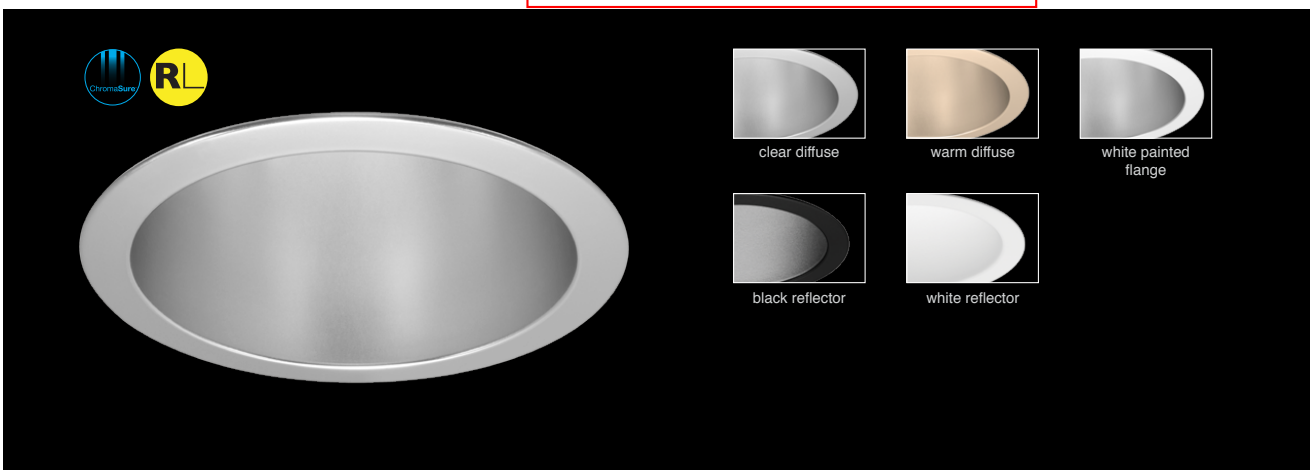
L6

ID+ 6"

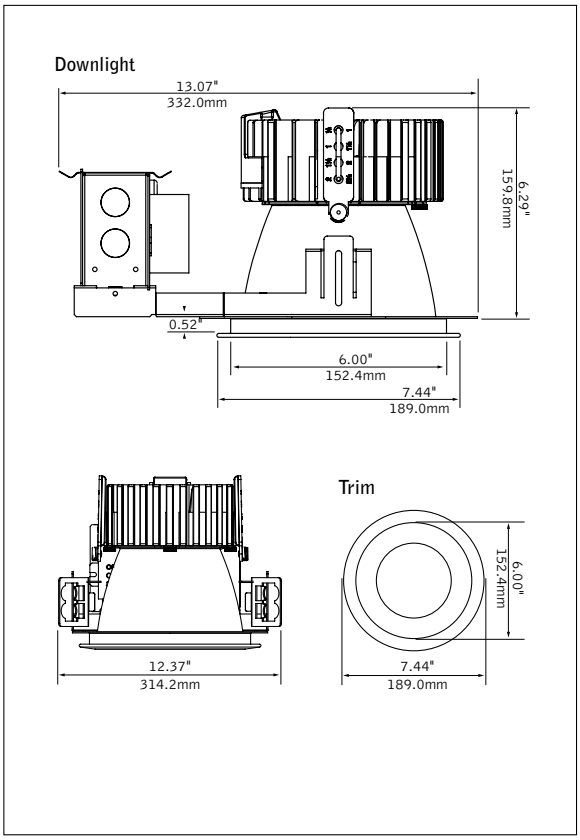
LED DOWNLIGHT

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURERS: FOCAL POINT; EATON PORTFOLIO - LD6B; PHILIPS - CALCULITE LED GEN 3; VANTAGE LTG - 6" LED/CAPELA;OR ENGINEER-APPROVED EQUAL.

FOCAL POINT



DIMENSIONAL DATA



FEATURES

ChromaSure: Color consistency resulting in a 2-step MacAdam ellipse across the entire ID+ product line.

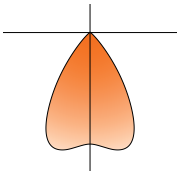
Field adjustability of ceiling thickness from 0.5" - 2.5".

50° cutoff to light source and its image.

Selection of dimming drivers available.

Right Light: Standard delivered lumen outputs 1000, 1500, 2000, 2500 and 3000.

PERFORMANCE



Clear Diffuse Reflector
3500k, 2000 Lumens

Delivered Lumens: 2000lm

Total System Watts: 21W

PRODUCT OVERVIEW

Lumen Output:	1000-3000lm
Wattage:	11-36W
LPW:	83-94
Spacing Criteria:	1.09
SDCM:	2
Lumen Maintenance:	L70 @ 63,000hrs

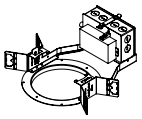
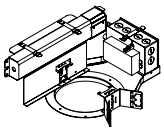
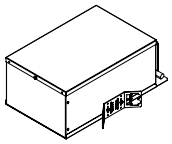
ENERGY STAR

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.Visit energystar.gov for model specifics.

fixture: project:

L6

HOUSING DETAILS

Standard	Emergency Battery	Chicago Plenum
		
L x W x H 13.07″ x 12.37″ x 6.29″	L x W x H 16.21″ x 12.37″ x 6.29″	Standard L x W x H 16.85″ x 11.45″ x 6.53″ Emergency L x W x H 16.85″ x 12.95″ x 6.53″

HOUSING SPECIFICATIONS

Construction

Thermally protected housing for new construction applications. Insulation to be kept 3" away from housing. Butterfly brackets allow mounting to ½ emt. Order bar hangers as an accessory. Die-cast aluminum heat sink designed for maximum thermal dissipation. Die-formed housing and integral junction box with (7) 1⁄2" pry outs. UL & cUL listed for (6) #14 AWG (3 in, 3 out) 90°C conductors and feed through–branch wiring. Accommodates ceiling thicknesses up to 0.5" standard, field adjustable up to 2.5" thickness. For thicker ceiling consult factory. Fixture will not exceed 5 lb.

Electrical

Choice of constant current dimming drivers. Power factor > .9 typical.

Emergency

Emergency Battery Pack: Bodine BSL17C–C2. Emergency output —7W for 90 minutes. Maximum mounting height: 23.3ft. (Black reflector color: 18.1ft.)

Labels

UL and cUL listed. Suitable for Dry or Damp Locations, indoor use only. Specify wet listed (WL) for recessed ceiling applications in indoor and outdoor locations. Lutron Drivers not recommended for outdoor environments below 0°C.

Lumen Maintenance

Reported: L70 at >63,000 hours. Derived from EPA TM-21 calculator

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty

LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

TRIM & LED SPECIFICATIONS

LED System

Proprietary array incorporates premium LEDs on a robust platform. May be specified in 2700K, 3000K, 3500K or 4000K, CRI>80. Color accuracy within 2 SDCM. Aluminum heat sink provides appropriate thermal management.

Aesthetics

Parabolic reflector cone ensures glare free optics. Reflector is .050 spun aluminum. Torsion springs pull trim tight to the ceiling with no visible fasteners within the trim. Trims are self-flanged. Non-painted trim matches reflector finish. White painted flange may also be specified.

Optics

50-degree cut–off to light source and its image.

PERFORMANCE CHART

Delivered Lumens	System Watts	LPW
1000	11	88
1500	17	87
2000	21	94
2500	29	85
3000	36	83

*Based on 3000/3500K. Clear Diffuse reflector cone. 80CRI Multipliers: 2700K: 0.94, 4000K: 0.1.06. 90CRI Multipliers: 2700K: 0.71, 3000/3500K: 0.83, 4000K: 0.89. Black Multiplier: 0.56. White Multiplier: 1.13. Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

Focal Point LLC reserves the right to change specifications for product improvement without notification.

HOUSING ORDERING

Housing Series		**FLC6D**
ID+ 6" Round Downlight	FLC6D	
Trim Type		
Round Flush	RF	
Round Overlap	RO	
Lumen Output		
1000 Lumens	1000L	
1500 Lumens	1500L	
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
Voltage		
120V	120	
277V**	277	
Driver		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron A-Series - 1% EcoSystem Digital (Consult factory for 3-wire control)	L3D	
Lutron H-Series - 1% Dimming	LH1	
Lutron 5-Series - 5% EcoSystem Digital (Available with 2000L & 2500L)	LU5	
DALI - 1% Dimming (Available with 2500L & 3000L)	D11	
DMX - 3-Channel, 0% Dimming	MZ3	
Housing Type		**T**
Thermally Protected, Non-IC	T	
Factory Options		
Bar Hangers	BH	
Chicago Plenum / National Plenum	CP	
Emergency Battery (Must order LC6EM trim)	EM	

TRIM & LED MODULE

Aperture		
6" Round Reflector	LC6	
6" Round Reflector - Emergency (Required for "EM" option)	LC6EM	
Trim Type		**RD**
Round	RD	
Lumen Output (Trim & Housing output must match)		
1000 Lumens	1000L	
1500 Lumens	1500L	
2000 Lumens	2000L	
2500 Lumens	2500L	
3000 Lumens	3000L	
Color Temperature		
2700K	27K	
2700K, 90CRI	927K	
3000K	30K	
3000K, 90CRI	930K	
3500K	35K	
3500K, 90CRI	935K	
4000K	40K	
4000K, 90CRI	940K	
Optic		**DN**
Downlight	DN	
Color		
Clear Diffuse	CD	
Warm Diffuse	WD	
Black (Black Painted flange only)	BK	
White (White Painted flange only)	WH	
Flange Finish		
Non-Painted (Clear and warm diffuse only)	NP	
Black Painted	BP	
White Painted	WP	
Factory Options		
Wet Listed (Not available with 90CRI)	WL	

A complete unit consists of two line items, housing and trim
Example: FLC6D-RO-1500L-120-LD1-T | LC6-RD-1500L-35K-DN-CD-NP

*For more information visit focalpointlights.com/reference or consult factory. **1500 and 2000 lumen outputs add 2 watts to system wattage.

L6

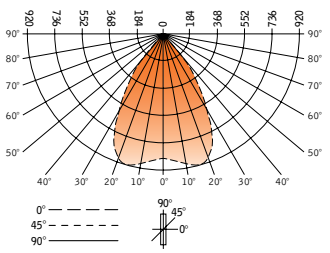
ID+ 6"

LED DOWNLIGHT

FLC6D-RO-1000L-120-L11-T / LC6-RO-1000L-35K / 40K-DN-CD-NP

Filename: FLC6DRO1000L_35K_40K_DNCD.IES
Test #: 1100924
Lumens: 961lm
System Watts: 11W
LPW: 87

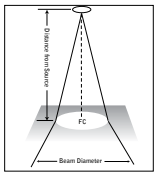
CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°
0°	836
5°	854
15°	920
25°	762
35°	347
45°	63
55°	7
65°	2
75°	0
85°	0
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	682	71.0
	0-40°	898	93.4
	0-60°	959	99.8
	0-90°	961	100.0
Total Luminaire	0-180°	961	100.0



FOOTCANDLE VALUES

0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.2'	52
6'	7.9'	23
8'	10.5'	13
10'	13.1'	8

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

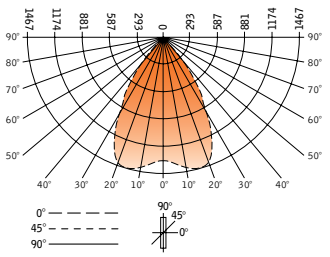
ID+ 6"

LED DOWNLIGHT

FLC6D-RO-1500L-120-L11-T / LC6-RO-1500L-35K / 40K-DN-CD-NP

Filename: FLC6DRO1500L_35K_40K_DNCD.IES
Test #: 1100922
Lumens: 1548lm
System Watts: 18W
LPW: 86

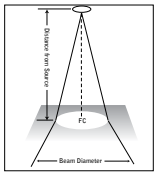
CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°
0°	1331
5°	1360
15°	1467
25°	1219
35°	558
45°	101
55°	13
65°	4
75°	2
85°	1
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	1090	70.4
	0-40°	1437	92.8
	0-60°	1537	99.3
	0-90°	1545	99.8
Total Luminaire	0-180°	1548	100.0



FOOTCANDLE VALUES

0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.3'	83
6'	7.9'	37
8'	10.6'	21
10'	13.2'	13

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

L6

ID+ 6"

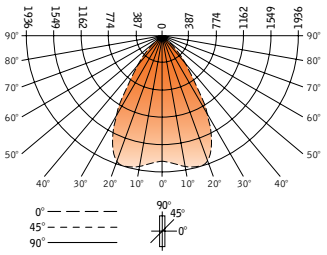
LED DOWNLIGHT

FLC6D-RO-2000L-120-L11-T / LC6-RO-2000L-35K / 40K-DN-CD-NP

Filename: FLC6DRO2000L_35K_40K_DNCD.IES
Test #: 1117169

Lumens: 2058
System Watts: 22W
LPW: 94

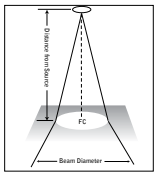
CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°
0°	1785
5°	1823
15°	1936
25°	1624
35°	749
45°	136
55°	18
65°	6
75°	2
85°	0
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	1448	70.4
	0-40°	1913	93.0
	0-60°	2049	99.6
	0-90°	2058	100.0
Total Luminaire	0-180°	2058	100.0



FOOTCANDLE VALUES

0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.3'	112
6'	7.9'	50
8'	10.6'	28
10'	13.2'	18

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

ID+ 6"

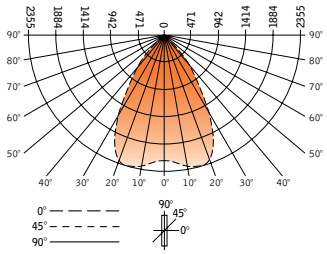
LED DOWNLIGHT

FLC6D-RO-2500L-120-L11-T / LC6-RO-2500L-35K / 40K-DN-CD-NP

Filename: FLC6DRO2500L_35K_40K_DNCD.IES
Test #: 1117167

Lumens: 2500
System Watts: 30W
LPW: 83

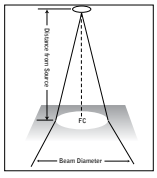
CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°
0°	2169
5°	2216
15°	2355
25°	1973
35°	909
45°	165
55°	21
65°	7
75°	3
85°	1
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	1760	70.4
	0-40°	2325	93.0
	0-60°	2489	99.6
	0-90°	2500	100.0
Total Luminaire	0-180°	2500	100.0



FOOTCANDLE VALUES

0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.3'	136
6'	7.9'	60
8'	10.6'	34
10'	13.2'	22

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

Go to www.focalpointlights.com for additional photometric data.

L6

ID+ 6"

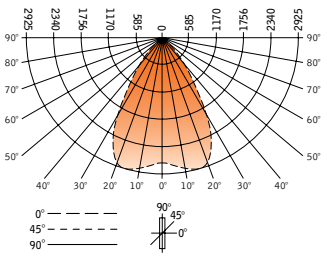
LED DOWNLIGHT

FLC6D-RO-3000L-120-L11-T / LC6-RO-3000L-35K / 40K-DN-CD-NP

Filename: FLC6DRO3000L_35K_40K_DNCD.IES
Test #: 1117168

Lumens: 3104
System Watts: 38W
LPW: 82

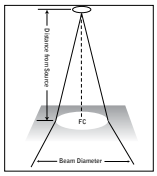
CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°
0°	2693
5°	2751
15°	2925
25°	2451
35°	1128
45°	205
55°	26
65°	9
75°	3
85°	1
90°	0

LUMEN SUMMARY

	Zone	Lumens	% Fixture
	0-30°	2186	70.4
	0-40°	2887	93.0
	0-60°	3091	99.6
	0-90°	3104	100.0
Total Luminaire	0-180°	3104	100.0



FOOTCANDLE VALUES

0° aiming angle - horizontal surface

Distance from source	Beam Diameter	Center Beam (FC)
4'	5.2'	168
6'	7.9'	75
8'	10.5'	42
10'	13.1'	27

Footcandle results based on AGI32; Reflectances=0/0/0; LLF=1

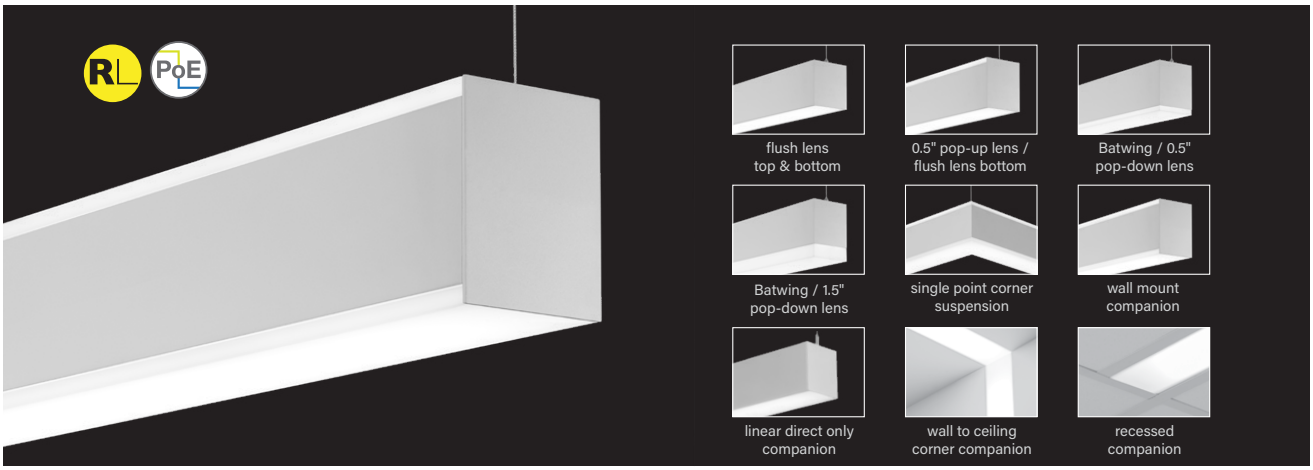
Go to www.focalpointlights.com for additional photometric data.

L7

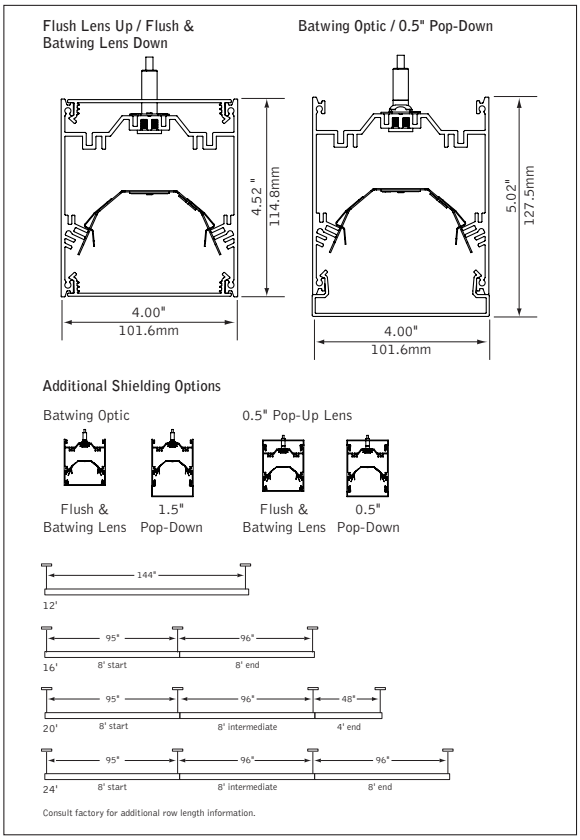
Seem® 4

LED DIRECT/INDIRECT

FOCAL POINT®



DIMENSIONAL DATA



FEATURES

Narrow extruded aluminum 4" linear direct/indirect LED with indirect batwing optic and Pop-lens options.

Features Right Light lumen levels allowing lumen and wattage design flexibility.

Individual units and continuous runs in 1' increments.

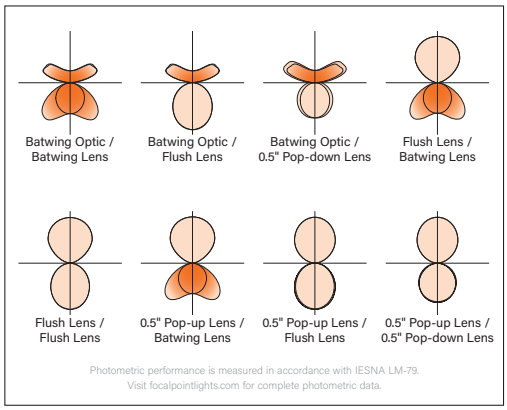
Frosted acrylic lenses provide uninterrupted illumination, without pixels or shadows.

LED position and lens material optimized to provide the perfect blend of high performance and visual comfort.

Choice of output levels and light distributions to meet a wide variety of application needs.

PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

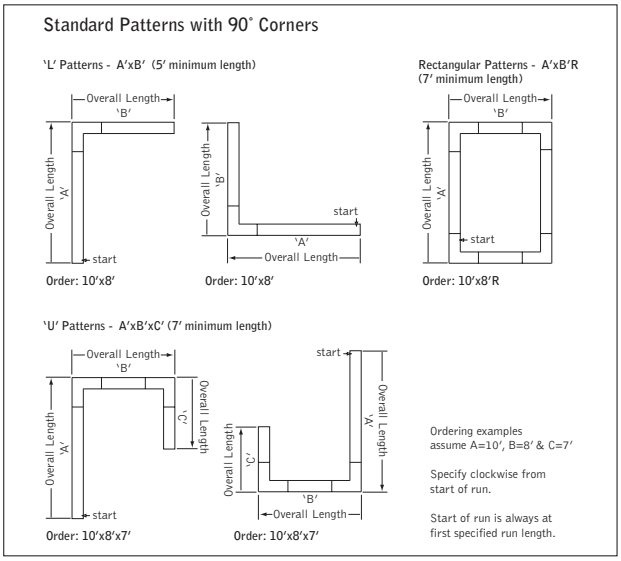
DISTRIBUTIONS



Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

fixture: project:

DETAILS



SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with >80 or 90 CRI, 3 SDCM. 3500K and 4000K with CRI>90 have a cyanosis observation index (COI) of 3.3 or less. LED modules and drivers are replaceable from below.

Construction

9-12' luminaires ship on 13' (157") pallets, forklift extensions of 72" are required to avoid damage. One piece extruded aluminum housing. Die cast aluminum end caps.
3' unit weight: 14.75lbs., 4' unit weight: 19lbs., 5' unit weight: 25lbs., 12' unit weight: 47lbs.

Optic

Reflectors fabricated of 22 Ga. steel finished in High Reflectance White powder coat. Extruded acrylic lens .085" thick with satin finish, up to 12' continuous.

Electrical

Luminaires are pre-wired with factory installed branch circuit wiring and over-molded quick connects. Standard 120-277V constant current driver includes 0-10V analog dimming. Dimming range 100% to 10%. Power factor > .9. PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires. PoE runs require an independent PoE node and power feed for each luminaire section.

Emergency Battery

Bodine BSL310LP. Emergency output - 10 watts for 90 minutes. Maximum mounting height: Flush Lens - 20.18ft. Maximum mounting height: Pop-Down Lens - 15.54ft

Labels

UL and cUL listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre-treatment. Canopy and cord white as standard.

Lumen Maintenance

Reported: L70 at >61,000 hours	Calculated: L70 at 395,000 hours
Reported: L90 at >61,000 hours	Calculated: L90 at 100,000 hours

Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty

LED system rated for operation in ambient environments up to 25°C. 5 year limited warranty.

4' PERFORMANCE CHART

See page 3

PROVIDE CABLE LENGTH PER FIXTURE MTG HT ON PLAN

FINISH PER ARCHITECT

L7

ORDERING

	FSM4BS
~~Luminaire Series~~	
Seem 4 Direct/Indirect LED — FSM4BS	
Shielding	
Batwing Optic Top / Batwing Lens Bottom — BWBW	
Batwing Optic Top / Flush Lens Bottom — BWFL	
Batwing Optic Top / 0.5" Pop-Down Bottom — BWPD05	
Batwing Optic Top / 1.5" Pop-Down Bottom — BWPD15 (3' - 12' individual lengths only)	
Flush Lens Top / Batwing Lens Bottom — FLBW	
Flush Lens Top / Flush Lens Bottom — FLFL	
0.5" Pop-Up Lens Top / Batwing Lens Bottom — PUBW	
0.5" Pop-Up Lens Top / Flush Lens Bottom — PUFL	
0.5" Pop-Up Lens Top / 0.5" Pop-Down Lens Bottom — PUPD05	
Direct Distribution (875 Lumens per foot maximum for xxPD05 & xxPD15. See driver compatibility chart on page 3.)	
275 Lumens per foot — 275DN	
375 Lumens per foot — 375DN	
625 Lumens per foot — 625DN	
875 Lumens per foot — 875DN	
1000 Lumens per foot — 1000DN	
1125 Lumens per foot — 1125DN	
1250 Lumens per foot — 1250DN	
Indirect Distribution (1000 Lumens per foot maximum for PUxx. See driver compatibility chart on page 3.)	
275 Lumens per foot — 275UP	
375 Lumens per foot — 375UP	
625 Lumens per foot — 625UP	
875 Lumens per foot — 875UP	
1000 Lumens per foot — 1000UP	
1125 Lumens per foot — 1125UP	
1250 Lumens per foot — 1250UP	
Color Temperature	
2700K, 80+ CRI **or** 2700K, 90+ CRI — 27K **or** 927K	
3000K, 80+ CRI **or** 3000K, 90+ CRI — 30K **or** 930K	
3500K, 80+ CRI **or** 3500K, 90+ CRI — 35K **or** 935K	
4000K, 80+ CRI **or** 4000K, 90+ CRI — 40K **or** 940K	
Circuits & Zones	
1 Circuit, non-emergency — 1C	
2 non-emergency circuits provide independent control of Direct and Indirect sources — 2C	
Consult Ordering Guide on page 4 for multiple circuiting and zoning options — _C_Z_DL	
Voltage	
120/277 UNV Volt — UNV	
Low Voltage — LV	
Control System & Dimming Level	
0-10V - 10% Dimming — LD1	
0-10V - 1% Dimming — L11	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.) — LVN	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming — LH1	
DALI - 1% Dimming (1000 lumens per foot max.) — D11	
Mounting	
24" Cable Suspension — C24__	
48" Cable Suspension — C48__	
96" Cable Suspension — C96__	
(Specify canopy color White (WH), Black (BK) or Titanium Silver (TS). Example: C24WH.) (Specify one of the following in place of "C" J - for 2" canopies at non-feed locations. CS - for sloped ceiling applications.)	
Factory Options (See Ordering Guide on page 4 for ordering details for DC, EC, EM & ECD.)	
Black Cord — BKCD	
Daylight Circuit — _DC	
Emergency Circuit — _EC	
Emergency Battery Pack† — _EM	
Emergency Control Device† — _ECD	
†(4' minimum. 120/277 Volt Only. EM or ECD not available at corners.)	
Finish	
Black — BK	
Titanium Silver — TS	
Matte White Housing — WH	
Luminaire/Row Length (3' minimum length. Leave blank for patterns. Lengths are nominal)	8 FT
Specify in 1' increments — X' (Lengths are nominal, up to 12' individuals available. See Run Chart (page 4) for ordering codes. Smaller increments available, consult factory for details. Leave blank for patterns.)	
Pattern Options	
'L' pattern (5' minimum length) — A' x B'	
'U' pattern (7' minimum length) — A' x B' x C'	
Rectangular pattern (7' minimum length) — A' x B'R	
(Consult factory for other pattern options)	

QS 10 DAY* Options in orange qualify for the Quickship program. Run lengths in 1' increments, 1000' total. Refer to Quickship Guide for complete details.

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DRIVER COMPATIBILITY CHART

Driver Description	Driver Code	Lumens per foot						
		275	375	625	875	1000	1125	1250
0-10V - 10% Dimming	LD1	✓	✓	✓	✓	✓	✓	✓
0-10V - 1% Dimming	L11	✓	✓	✓	✓	✓	✓	✓
DALI - 1% Dimming	D11	✓	✓	✓	✓	✓		
Lutron Hi-Lume - 1% EcoSystem	LH1	✓	✓	✓	✓	✓	✓	✓

4' PERFORMANCE CHART

Direct Distribution	Indirect Distribution	Distribution % (Direct/Indirect)	Total Delivered Lumens	Tested System Watts	Lumens Per Watt (LPW)						Tested System Watts	Lumens Per Watt (LPW)		
					BWBW	BWFL	FLBW	FLFL	PUBW	PUFL		BWPD05	BWPD15	PUPD05
	275	50/50	2200	22	116	118	105	107	103	105	25	103	106	93
	375	42/58	2600	25	118	119	108	109	105	106	28	106	109	95
	625	31/69	3600	35	124	124	110	111	105	106	38	113	116	98
275DN	875	24/76	4600	46	124	125	108	109	102	103	49	116	118	97
	1000	22/78	5100	50	124	124	107	108	101	102	53	116	118	97
	1125	20/80	5600	52	122	123	108	109	—	—	55	115	117	—
	1250	18/82	6100	57	122	123	107	108	—	—	60	116	118	—
	275	58/42	2600	25	119	119	109	109	107	107	30	99	93	91
	375	50/50	3000	28	120	120	111	111	108	108	33	102	96	94
	625	38/62	4000	37	125	125	112	112	108	108	43	109	105	96
375DN	875	30/70	5000	49	125	125	110	110	104	105	54	112	109	96
	1000	27/73	5500	53	125	125	109	109	103	104	58	113	110	96
	1125	25/75	6000	55	123	123	110	110	—	—	60	112	110	—
	1250	23/77	6500	59	123	123	109	109	—	—	65	113	111	—
	275	69/31	3600	33	116	118	109	111	108	109	41	95	99	89
	375	63/37	4000	36	117	119	110	112	108	110	44	97	102	91
	625	50/50	5000	46	121	123	111	113	108	109	54	104	107	94
625DN	875	42/58	6000	57	122	123	110	111	105	106	65	107	110	94
	1000	38/62	6500	62	122	123	109	110	104	105	70	108	111	94
	1125	36/64	7000	63	121	122	109	110	—	—	71	108	110	—
	1250	33/67	7500	68	121	122	109	110	—	—	76	109	111	—
	275	76/24	4600	43	114	114	109	109	108	108	55	90	94	86
	375	70/30	5000	47	115	115	110	110	108	109	58	92	96	87
	625	58/42	6000	56	119	119	111	111	108	108	68	97	101	90
875DN	875	50/50	7000	68	120	120	110	110	105	106	79	101	104	91
	1000	47/53	7500	72	120	120	109	109	105	105	83	102	105	91
	1125	44/56	8000	74	119	119	109	109	—	—	85	102	105	—
	1250	41/59	8500	78	119	119	109	109	—	—	90	103	106	—
	275	78/22	5100	48	113	113	108	108	107	107	—	—	—	—
	375	73/27	5500	51	114	114	109	109	108	108	—	—	—	—
	625	62/38	6500	60	117	117	110	110	107	108	—	—	—	—
1000DN	875	53/47	7500	72	119	119	109	109	105	105	—	—	—	—
	1000	50/50	8000	76	119	119	109	109	105	105	—	—	—	—
	1125	47/53	8500	78	118	118	109	109	—	—	—	—	—	—
	1250	44/56	9000	82	118	118	108	108	—	—	—	—	—	—
	275	80/20	5600	53	112	113	108	109	107	108	—	—	—	—
	375	75/25	6000	56	113	114	109	110	107	108	—	—	—	—
	625	64/36	7000	66	116	117	110	110	107	108	—	—	—	—
1125DN	875	56/44	8000	77	118	118	109	109	105	106	—	—	—	—
	1000	53/47	8500	81	118	118	108	109	105	105	—	—	—	—
	1125	50/50	9000	83	117	117	109	109	—	—	—	—	—	—
	1250	47/53	9500	88	117	118	108	109	—	—	—	—	—	—
	275	82/18	6100	57	111	112	107	109	106	107	—	—	—	—
	375	77/23	6500	60	112	113	108	110	106	108	—	—	—	—
	625	67/33	7500	70	115	116	109	110	106	107	—	—	—	—
1250DN	875	59/41	8500	81	116	117	108	109	105	106	—	—	—	—
	1000	56/44	9000	86	116	117	108	110	104	105	—	—	—	—
	1125	53/47	9500	88	116	117	108	108	—	—	—	—	—	—
	1250	50/50	10000	92	116	117	107	108	—	—	—	—	—	—

*Based on 3500k, 4' lengths. *Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%. Pop-Up Lens/Pop-down lens lumen output may vary +/- 5%

L7

Ordering Guide

Linear Circuitry, Zones & Factory Options

HOW TO USE THIS GUIDE

Fill out the worksheet on the following page to specify your requirements for circuitry, zones, and factory options.

Refer to the run chart for standard run configurations, consult factory for custom configurations.

Complete the Totals / Ordering Codes at the bottom of the worksheet and add to your ordering logic on the cut sheet.

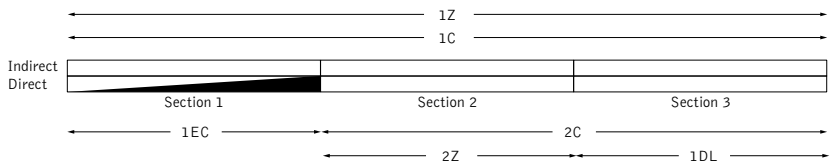
Submit the worksheet along with your order.

EXAMPLE

TOTAL RUN LENGTH: 24ft **JOB NAME:** _____ **FIXTURE TYPE:** _____

HOUSING SECTION	SECTION LENGTH	LIGHT DISTRIBUTION	SHARED ELECTRICAL FEED, NORMAL POWER			FACTORY OPTIONS			
						SEPARATE ELECTRICAL FEEDS			
			SWITCHING CIRCUIT	DIMMING ZONE	DAYLIGHT ZONE	DAYLIGHT CIRCUIT	EMERGENCY CIRCUIT	ECD	EM
1	8	Indirect	1C	1Z					
		Direct					1EC		
2	8	Indirect	1C	1Z					
		Direct	2C	2Z					
3	8	Indirect	1C	1Z					
		Direct	2C		1DL				
Totals / Ordering Codes			**2C**	**2Z**	**1DL**		**1EC**		

ORDERING: FSM4BS-FLFL-275DN-625UP-35K- **2C2Z1DL** -UNV-LD1-C24WH- **1EC** -WH-24ft



KEY	
C = Switching Circuit Switched Hot / Shared Neutral	**DC = Daylight Circuit** Switched Hot / Separate Neutral
Z = Dimming Zone Dimming Control Wires	**EC = Emergency Circuit** Switched Hot / Separate Neutral
DL = Daylight Zone Daylight Dimming Control Wires	**ECD = Emergency Control Device** Unswitched Hot / Separate Neutral
	EM = Emergency Battery Unswitched Hot / Shared Neutral

DEFAULTS

- Zones and Factory Options illuminate entire sections from 4' to 8' in length.
- EC, EM, and ECD only available for direct distribution.
- One shared or isolated circuit and zone required per housing section.
- Additional electrical feed required for applications greater than three shared circuits and zones.
- Limit of one EM or ECD per housing section.
- Each EC, DC and ECD require an additional electrical feed.
- ECD not available in the same housing section as EC.
- Longer lead times and additional pricing may apply for custom run configurations.

CUSTOM LENGTHS

- If partial illumination of emergency or daylight section is required, indicate in ordering guide and add "partial illumination" in Order Notes. Drawing required.
- Engineering validation required, longer lead times may apply.

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Ordering Guide Worksheet

Linear Circuitry, Zones & Factory Options

WORKSHEET

TOTAL RUN LENGTH: _____ **JOB NAME:** _____ **FIXTURE TYPE:** _____

HOUSING SECTION	SECTION LENGTH	LIGHT DISTRIBUTION	SHARED ELECTRICAL FEED, NORMAL POWER			FACTORY OPTIONS			
						SEPARATE ELECTRICAL FEEDS			EM
			SWITCHING CIRCUIT	DIMMING ZONE	DAYLIGHT ZONE	DAYLIGHT CIRCUIT	EMERGENCY CIRCUIT	ECD	
1		Indirect							
		Direct							
2		Indirect							
		Direct							
3		Indirect							
		Direct							
4		Indirect							
		Direct							
5		Indirect							
		Direct							
6		Indirect							
		Direct							
7		Indirect							
		Direct							
8		Indirect							
		Direct							
9		Indirect							
		Direct							
10		Indirect							
		Direct							
11		Indirect							
		Direct							
12		Indirect							
		Direct							
Totals / Ordering Codes			_C	_Z	_DL	_DC	_EC	_ECD	_EM

Combine to create Circuits & Zones ordering code

Enter as individual Factory Options

RUN CHART

Run Length (ft)	Housing Configuration Section Lengths	Ordering Code
9	5 + 4	9
	9	9(IND)
10	6 + 4	10
	5 + 5	10(5+5)
	10	10(IND)
11	7 + 4	11
	11	11(IND)
12	8 + 4	12
	6 + 6	12(6+6)
	12	12(IND)
13	8 + 5	13
14	8 + 6	14
15	8 + 7	15
16	8 + 8	16
17	8 + 5 + 4	17
18	8 + 6 + 4	18

Run Length (ft)	Housing Configuration Section Lengths	Ordering Code
19	8 + 7 + 4	19
20	8 + 8 + 4	20
21	8 + 8 + 5	21
22	8 + 8 + 6	22
23	8 + 8 + 7	23
24	8 + 8 + 8	24
25	8 + 8 + 5 + 4	25
26	8 + 8 + 6 + 4	26
27	8 + 8 + 7 + 4	27
28	8 + 8 + 8 + 4	28
29	8 + 8 + 8 + 5	29
30	8 + 8 + 8 + 6	30
31	8 + 8 + 8 + 7	31
32	8 + 8 + 8 + 8	32
33	8 + 8 + 8 + 5 + 4	33
34	8 + 8 + 8 + 6 + 4	34

Run Length (ft)	Housing Configuration Section Lengths	Ordering Code
35	8 + 8 + 8 + 7 + 4	35
36	8 + 8 + 8 + 8 + 4	36
37	8 + 8 + 8 + 8 + 5	37
38	8 + 8 + 8 + 8 + 6	38
39	8 + 8 + 8 + 8 + 7	39
40	8 + 8 + 8 + 8 + 8	40
41	8 + 8 + 8 + 8 + 5 + 4	41
42	8 + 8 + 8 + 8 + 6 + 4	42
43	8 + 8 + 8 + 8 + 7 + 4	43
44	8 + 8 + 8 + 8 + 8 + 4	44
45	8 + 8 + 8 + 8 + 8 + 5	45
46	8 + 8 + 8 + 8 + 8 + 6	46
47	8 + 8 + 8 + 8 + 8 + 7	47
48	8 + 8 + 8 + 8 + 8 + 8	48

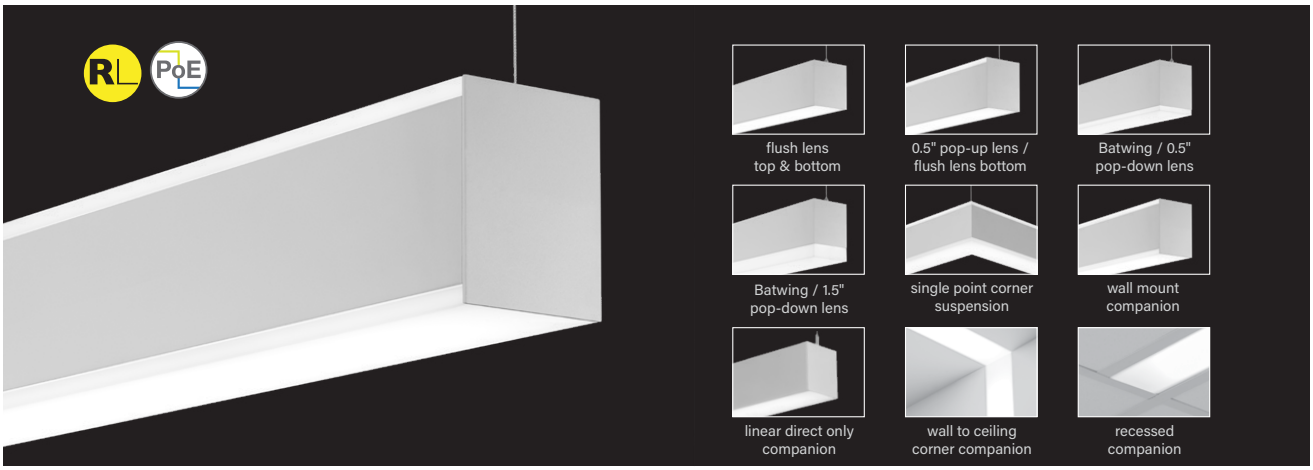
Standard run configurations, consult factory for custom configurations.

L7A

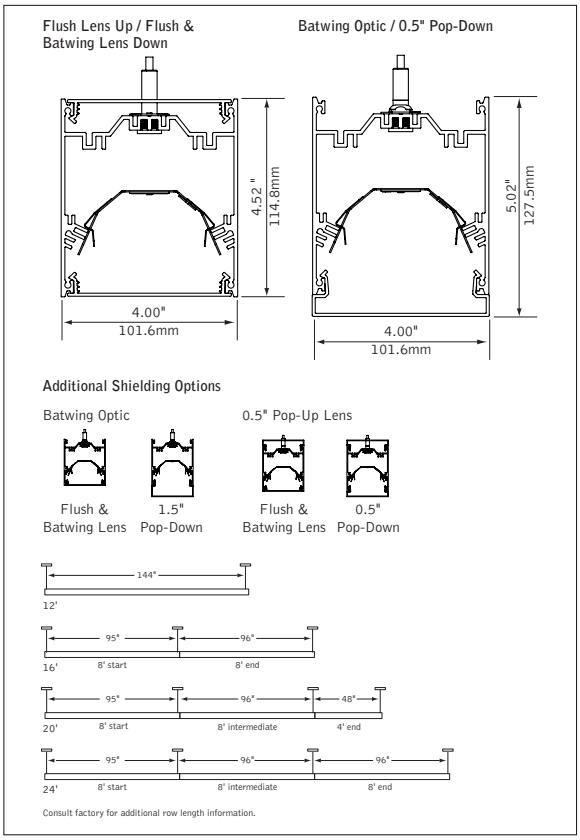
Seem® 4

LED DIRECT/INDIRECT

FOCAL POINT®



DIMENSIONAL DATA



FEATURES

Narrow extruded aluminum 4" linear direct/indirect LED with indirect batwing optic and Pop-lens options.

Features Right Light lumen levels allowing lumen and wattage design flexibility.

Individual units and continuous runs in 1' increments.

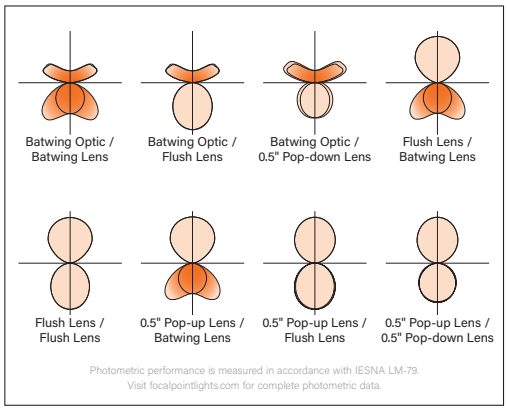
Frosted acrylic lenses provide uninterrupted illumination, without pixels or shadows.

LED position and lens material optimized to provide the perfect blend of high performance and visual comfort.

Choice of output levels and light distributions to meet a wide variety of application needs.

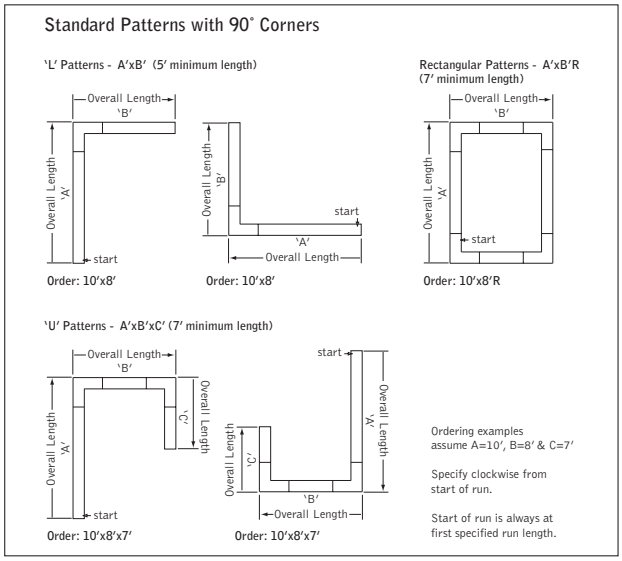
PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

DISTRIBUTIONS



fixture: project:

DETAILS



SPECIFICATIONS

LED System
Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with >80 or 90 CRI, 3 SDCM. 3500K and 4000K with CRI>90 have a cyanosis observation index (COI) of 3.3 or less. LED modules and drivers are replaceable from below.

Construction
9-12' luminaires ship on 13' (157") pallets, forklift extensions of 72" are required to avoid damage. One piece extruded aluminum housing. Die cast aluminum end caps.
3' unit weight: 14.75lbs., 4' unit weight: 19lbs., 5' unit weight: 25lbs., 12' unit weight: 47lbs.

Optic
Reflectors fabricated of 22 Ga. steel finished in High Reflectance White powder coat. Extruded acrylic lens .085" thick with satin finish, up to 12' continuous.

Electrical
Luminaires are pre-wired with factory installed branch circuit wiring and over-molded quick connects. Standard 120-277V constant current driver includes 0-10V analog dimming. Dimming range 100% to 10%. Power factor > .9. PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires. PoE runs require an independent PoE node and power feed for each luminaire section.

Emergency Battery
Bodine BSL310LP. Emergency output - 10 watts for 90 minutes. Maximum mounting height: Flush Lens - 20.18ft. Maximum mounting height: Pop-Down Lens - 15.54ft

Labels
UL and cUL listed. Suitable for Dry or Damp Locations, indoor use only.

Finish
Polyester powder coat applied over a multi-stage pre-treatment. Canopy and cord white as standard.

Lumen Maintenance
Reported: L70 at >61,000 hours — Calculated: L70 at 395,000 hours
Reported: L90 at >61,000 hours — Calculated: L90 at 100,000 hours
Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.

Reliability
At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty
LED system rated for operation in ambient environments up to 25°C. 5 year limited warranty.

4' PERFORMANCE CHART
See page 3

PROVIDE CABLE LENGTH PER FIXTURE MTG HT ON PLAN

FINISH PER ARCHITECT

L7A

ORDERING

		FSM4BS
~~**Luminaire Series**~~		
Seem 4 Direct/Indirect LED	FSM4BS	
Shielding		
Batwing Optic Top / Batwing Lens Bottom	BWBW	
Batwing Optic Top / Flush Lens Bottom	BWFL	
Batwing Optic Top / 0.5" Pop-Down Bottom	BWPD05	
Batwing Optic Top / 1.5" Pop-Down Bottom (3' - 12' individual lengths only)	BWPD15	
Flush Lens Top / Batwing Lens Bottom	FLBW	
Flush Lens Top / Flush Lens Bottom	FLFL	
0.5" Pop-Up Lens Top / Batwing Lens Bottom	PUBW	
0.5" Pop-Up Lens Top / Flush Lens Bottom	PUFL	
0.5" Pop-Up Lens Top / 0.5" Pop-Down Lens Bottom	PUPD05	
Direct Distribution (875 Lumens per foot maximum for xxPD05 & xxPD15. See driver compatibility chart on page 3.)		
275 Lumens per foot	275DN	
375 Lumens per foot	375DN	
625 Lumens per foot	625DN	
875 Lumens per foot	875DN	
1000 Lumens per foot	1000DN	
1125 Lumens per foot	1125DN	
1250 Lumens per foot	1250DN	
Indirect Distribution (1000 Lumens per foot maximum for PUxx. See driver compatibility chart on page 3.)		
275 Lumens per foot	275UP	
375 Lumens per foot	375UP	
625 Lumens per foot	625UP	
875 Lumens per foot	875UP	
1000 Lumens per foot	1000UP	
1125 Lumens per foot	1125UP	
1250 Lumens per foot	1250UP	
Color Temperature		
2700K, 80+ CRI **or** 2700K, 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 3000K, 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 3500K, 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 4000K, 90+ CRI	40K **or** 940K	
Circuits & Zones		
1 Circuit, non-emergency	1C	
2 non-emergency circuits provide independent control of Direct and Indirect sources	2C	
Consult Ordering Guide on page 4 for multiple circuiting and zoning options	_C_Z_DL	
Voltage		
120/277 UNV Volt	UNV	
Low Voltage	LV	
Control System & Dimming Level		
0-10V - 10% Dimming	LD1	
0-10V - 1% Dimming	L11	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.)	LVN	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
DALI - 1% Dimming (1000 lumens per foot max.)	D11	
Mounting		
24" Cable Suspension	C24__	
48" Cable Suspension	C48__	
96" Cable Suspension	C96__	
(Specify canopy color White (WH), Black (BK) or Titanium Silver (TS). Example: C24WH.) (Specify one of the following in place of "C" J - for 2" canopies at non-feed locations. CS - for sloped ceiling applications.)		
Factory Options (See Ordering Guide on page 4 for ordering details for DC, EC, EM & ECD.)		
Black Cord	BKCD	
Daylight Circuit	_DC	
Emergency Circuit	_EC	
Emergency Battery Pack†	_EM	
Emergency Control Device†	_ECD	
†(4' minimum. 120/277 Volt Only. EM or ECD not available at corners.)		
Finish		
Black	BK	
Titanium Silver	TS	
Matte White Housing	WH	
Luminaire/Row Length (3' minimum length. Leave blank for patterns. Lengths are nominal)		8 FT
Specify in 1' increments (Lengths are nominal, up to 12' individuals available. See Run Chart (page 4) for ordering codes. Smaller increments available, consult factory for details. Leave blank for patterns.)	X'	
Pattern Options		
'L' pattern (5' minimum length)	A' x B'	
'U' pattern (7' minimum length)	A' x B' x C'	
Rectangular pattern (7' minimum length)	A' x B'R	
(Consult factory for other pattern options)		

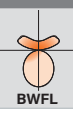
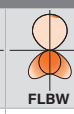
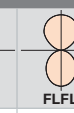
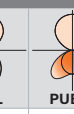
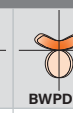
QS 10 DAY* Options in orange qualify for the Quickship program. Run lengths in 1' increments, 1000' total. Refer to Quickship Guide for complete details.

L7A

DRIVER COMPATIBILITY CHART

Driver Description	Driver Code	Lumens per foot						
		275	375	625	875	1000	1125	1250
0-10V - 10% Dimming	LD1	✓	✓	✓	✓	✓	✓	✓
0-10V - 1% Dimming	L11	✓	✓	✓	✓	✓	✓	✓
DALI - 1% Dimming	D11	✓	✓	✓	✓	✓		
Lutron Hi-Lume - 1% EcoSystem	LH1	✓	✓	✓	✓	✓	✓	✓

4' PERFORMANCE CHART

Direct Distribution	Indirect Distribution	Distribution % (Direct/Indirect)	Total Delivered Lumens	Tested System Watts	Lumens Per Watt (LPW)						Tested System Watts	Lumens Per Watt (LPW)		
					 BWBW	 BWFL	 FLBW	 FLFL	 PUBW	 PUFL		 BWPD05	 BWPD15	 PUPD05
	275	50/50	2200	22	116	118	105	107	103	105	25	103	106	93
	375	42/58	2600	25	118	119	108	109	105	106	28	106	109	95
	625	31/69	3600	35	124	124	110	111	105	106	38	113	116	98
275DN	875	24/76	4600	46	124	125	108	109	102	103	49	116	118	97
	1000	22/78	5100	50	124	124	107	108	101	102	53	116	118	97
	1125	20/80	5600	52	122	123	108	109	—	—	55	115	117	—
	1250	18/82	6100	57	122	123	107	108	—	—	60	116	118	—
	275	58/42	2600	25	119	119	109	109	107	107	30	99	93	91
	375	50/50	3000	28	120	120	111	111	108	108	33	102	96	94
	625	38/62	4000	37	125	125	112	112	108	108	43	109	105	96
375DN	875	30/70	5000	49	125	125	110	110	104	105	54	112	109	96
	1000	27/73	5500	53	125	125	109	109	103	104	58	113	110	96
	1125	25/75	6000	55	123	123	110	110	—	—	60	112	110	—
	1250	23/77	6500	59	123	123	109	109	—	—	65	113	111	—
	275	69/31	3600	33	116	118	109	111	108	109	41	95	99	89
	375	63/37	4000	36	117	119	110	112	108	110	44	97	102	91
	625	50/50	5000	46	121	123	111	113	108	109	54	104	107	94
625DN	875	42/58	6000	57	122	123	110	111	105	106	65	107	110	94
	1000	38/62	6500	62	122	123	109	110	104	105	70	108	111	94
	1125	36/64	7000	63	121	122	109	110	—	—	71	108	110	—
	1250	33/67	7500	68	121	122	109	110	—	—	76	109	111	—
	275	76/24	4600	43	114	114	109	109	108	108	55	90	94	86
	375	70/30	5000	47	115	115	110	110	108	109	58	92	96	87
	625	58/42	6000	56	119	119	111	111	108	108	68	97	101	90
875DN	875	50/50	7000	68	120	120	110	110	105	106	79	101	104	91
	1000	47/53	7500	72	120	120	109	109	105	105	83	102	105	91
	1125	44/56	8000	74	119	119	109	109	—	—	85	102	105	—
	1250	41/59	8500	78	119	119	109	109	—	—	90	103	106	—
	275	78/22	5100	48	113	113	108	108	107	107	—	—	—	—
	375	73/27	5500	51	114	114	109	109	108	108	—	—	—	—
	625	62/38	6500	60	117	117	110	110	107	108	—	—	—	—
1000DN	875	53/47	7500	72	119	119	109	109	105	105	—	—	—	—
	1000	50/50	8000	76	119	119	109	109	105	105	—	—	—	—
	1125	47/53	8500	78	118	118	109	109	—	—	—	—	—	—
	1250	44/56	9000	82	118	118	108	108	—	—	—	—	—	—
	275	80/20	5600	53	112	113	108	109	107	108	—	—	—	—
	375	75/25	6000	56	113	114	109	110	107	108	—	—	—	—
	625	64/36	7000	66	116	117	110	110	107	108	—	—	—	—
1125DN	875	56/44	8000	77	118	118	109	109	105	106	—	—	—	—
	1000	53/47	8500	81	118	118	108	109	105	105	—	—	—	—
	1125	50/50	9000	83	117	117	109	109	—	—	—	—	—	—
	1250	47/53	9500	88	117	118	108	109	—	—	—	—	—	—
	275	82/18	6100	57	111	112	107	109	106	107	—	—	—	—
	375	77/23	6500	60	112	113	108	110	106	108	—	—	—	—
	625	67/33	7500	70	115	116	109	110	106	107	—	—	—	—
1250DN	875	59/41	8500	81	116	117	108	109	105	106	—	—	—	—
	1000	56/44	9000	86	116	117	108	110	104	105	—	—	—	—
	1125	53/47	9500	88	116	117	108	108	—	—	—	—	—	—
	1250	50/50	10000	92	116	117	107	108	—	—	—	—	—	—

*Based on 3500k, 4' lengths. *Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%. Pop-Up Lens/Pop-down lens lumen output may vary +/- 5%

L7A

Ordering Guide

Linear Circuitry, Zones & Factory Options

HOW TO USE THIS GUIDE

Fill out the worksheet on the following page to specify your requirements for circuitry, zones, and factory options.

Refer to the run chart for standard run configurations, consult factory for custom configurations.

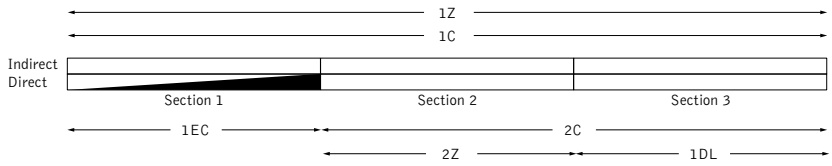
Complete the Totals / Ordering Codes at the bottom of the worksheet and add to your ordering logic on the cut sheet.

Submit the worksheet along with your order.

TOTAL RUN LENGTH: 24ft **JOB NAME:** _____ **FIXTURE TYPE:** _____

	HOUSING SECTION	SECTION LENGTH	LIGHT DISTRIBUTION	SHARED ELECTRICAL FEED, NORMAL POWER			FACTORY OPTIONS			
							SEPARATE ELECTRICAL FEEDS			
				SWITCHING CIRCUIT	DIMMING ZONE	DAYLIGHT ZONE	DAYLIGHT CIRCUIT	EMERGENCY CIRCUIT	ECD	EM
EXAMPLE	1	8	Indirect	1C	1Z					
			Direct					1EC		
	2	8	Indirect	1C	1Z					
			Direct	2C	2Z					
	3	8	Indirect	1C	1Z					
			Direct	2C		1DL				
	Totals / Ordering Codes			2C	2Z	1DL		1EC		

ORDERING: FSM4BS-FLFL-275DN-625UP-35K- **2C2Z1DL** -UNV-LD1-C24WH- **1EC** -WH-24ft



KEY	
C = Switching Circuit Switched Hot / Shared Neutral	**DC = Daylight Circuit** Switched Hot / Separate Neutral
Z = Dimming Zone Dimming Control Wires	**EC = Emergency Circuit** Switched Hot / Separate Neutral
DL = Daylight Zone Daylight Dimming Control Wires	**ECD = Emergency Control Device** Unswitched Hot / Separate Neutral
	EM = Emergency Battery Unswitched Hot / Shared Neutral

DEFAULTS

- Zones and Factory Options illuminate entire sections from 4' to 8' in length.
- EC, EM, and ECD only available for direct distribution.
- One shared or isolated circuit and zone required per housing section.
- Additional electrical feed required for applications greater than three shared circuits and zones.
- Limit of one EM or ECD per housing section.
- Each EC, DC and ECD require an additional electrical feed.
- ECD not available in the same housing section as EC.
- Longer lead times and additional pricing may apply for custom run configurations.

CUSTOM LENGTHS

- If partial illumination of emergency or daylight section is required, indicate in ordering guide and add "partial illumination" in Order Notes. Drawing required.
- Engineering validation required, longer lead times may apply.

L7A

Ordering Guide Worksheet

Linear Circuitry, Zones & Factory Options

WORKSHEET

TOTAL RUN LENGTH: _____ **JOB NAME:** _____ **FIXTURE TYPE:** _____

HOUSING SECTION	SECTION LENGTH	LIGHT DISTRIBUTION	SHARED ELECTRICAL FEED, NORMAL POWER			FACTORY OPTIONS			
						SEPARATE ELECTRICAL FEEDS			EM
			SWITCHING CIRCUIT	DIMMING ZONE	DAYLIGHT ZONE	DAYLIGHT CIRCUIT	EMERGENCY CIRCUIT	ECD	
1		Indirect							
		Direct							
2		Indirect							
		Direct							
3		Indirect							
		Direct							
4		Indirect							
		Direct							
5		Indirect							
		Direct							
6		Indirect							
		Direct							
7		Indirect							
		Direct							
8		Indirect							
		Direct							
9		Indirect							
		Direct							
10		Indirect							
		Direct							
11		Indirect							
		Direct							
12		Indirect							
		Direct							
Totals / Ordering Codes			_C	_Z	_DL	_DC	_EC	_ECD	_EM

Combine to create Circuits & Zones ordering code

Enter as individual Factory Options

RUN CHART

Run Length (ft)	Housing Configuration Section Lengths	Ordering Code
9	5 + 4	9
	9	9(IND)
10	6 + 4	10
	5 + 5	10(5+5)
	10	10(IND)
11	7 + 4	11
	11	11(IND)
12	8 + 4	12
	6 + 6	12(6+6)
	12	12(IND)
13	8 + 5	13
14	8 + 6	14
15	8 + 7	15
16	8 + 8	16
17	8 + 5 + 4	17
18	8 + 6 + 4	18

Run Length (ft)	Housing Configuration Section Lengths	Ordering Code
19	8 + 7 + 4	19
20	8 + 8 + 4	20
21	8 + 8 + 5	21
22	8 + 8 + 6	22
23	8 + 8 + 7	23
24	8 + 8 + 8	24
25	8 + 8 + 5 + 4	25
26	8 + 8 + 6 + 4	26
27	8 + 8 + 7 + 4	27
28	8 + 8 + 8 + 4	28
29	8 + 8 + 8 + 5	29
30	8 + 8 + 8 + 6	30
31	8 + 8 + 8 + 7	31
32	8 + 8 + 8 + 8	32
33	8 + 8 + 8 + 5 + 4	33
34	8 + 8 + 8 + 6 + 4	34

Run Length (ft)	Housing Configuration Section Lengths	Ordering Code
35	8 + 8 + 8 + 7 + 4	35
36	8 + 8 + 8 + 8 + 4	36
37	8 + 8 + 8 + 8 + 5	37
38	8 + 8 + 8 + 8 + 6	38
39	8 + 8 + 8 + 8 + 7	39
40	8 + 8 + 8 + 8 + 8	40
41	8 + 8 + 8 + 8 + 5 + 4	41
42	8 + 8 + 8 + 8 + 6 + 4	42
43	8 + 8 + 8 + 8 + 7 + 4	43
44	8 + 8 + 8 + 8 + 8 + 4	44
45	8 + 8 + 8 + 8 + 8 + 5	45
46	8 + 8 + 8 + 8 + 8 + 6	46
47	8 + 8 + 8 + 8 + 8 + 7	47
48	8 + 8 + 8 + 8 + 8 + 8	48

Standard run configurations, consult factory for custom configurations.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L8

FEATURES & SPECIFICATIONS

INTENDED USE — Ideal for use in applications where smart, energy-efficient fixtures are desired. Typical applications include parking garages, canopies, transportation, schools, hospitals, cold storage and exterior retail environments where moisture or dust is a concern. Polycarbonate enclosure protects fixture while remaining easy to service and clean. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.**

CONSTRUCTION — UV-stabilized, injection-molded, impact-resistant, frosted polycarbonate housing with continuous poured in place, closed-cell gasket. 20-gauge steel channel and channel cover. Aluminum sheet metal board plate for thermal conduction and support. Captive, tamper-resistant, polycarbonate latches standard (8 Torx T-20 tamper-resistant screws included). Stainless steel latches also available. Fixture design allows for approximately 4% up-light.

OPTICS — UV-stabilized, injection-molded, impact-resistant, clear transparent and frosted, polycarbonate lens with aesthetic rib detail (.080" thick). Miro 5 aluminum reflector used to achieve wide distribution.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Standard 0-10V dimming. Integral 6kV/3kA surge protection, tested in accordance to IEEE/ANSI standards. >L88 at 60,000 hours (see chart on page 3).

INSTALLATION — Stainless steel surface mount brackets standard (2 included) allows for ceiling or suspended mount. A variety of stainless steel mounting options also available: J-box mounting and mounting brackets for suspension with aircraft cable (cable not included). Optional stainless steel V-hooks available for chain hanging (chain not included). Surface conduit entry on each end and on top. For horizontal and vertical mounting on a wall, application must be under a covered ceiling and QMB option recommended. 1/2" - 3/4" KO. When wall mounted the product will be rated for damp location only.

LISTINGS — CSA Certified to UL and C-UL standards. For use in ambient temperatures ranging from -20°F (-29°C) to 104°F(40°C). VAP LED is wet location listed for covered ceiling applications. IP65 and IP66 rated. VAP LED is NSF Splash Zone rated when suspended or ceiling mounted. When wall mounted the product will be rated for damp location only. 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.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

For installed Rough Service Product(s), Acuity warrants that, for the lifetime of the product(s), the polycarbonate lens and/or polycarbonate housing will withstand breakage resulting from occasional physical abuse and rough handling (the "Rough Service Warranty"), not withstanding the vandalism exclusion set forth at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

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.

PROVIDE SPECIFIED FIXTURE LITHONIA LIGHTING VAP LED, LUMAX LIGHTING VWBTLED SERIES, COLUMBIA LIGHTING LXEM, OR ENGINEER APPROVED EQUAL.

ARCHWAY™ PASSAGE™

Rough Service Fixture

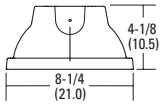
VAP LED

CEILING/
SUSPEND MOUNT

Specifications

Length: 54-3/4 (139.1)
Width: 8-1/4 (21.0)
Depth: 4-1/8 (10.5)
Weight: 13.5 lbs. (5.9 kg)

All dimensions are shown in inches (centimeters) unless otherwise noted.



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® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

L8

VAP Linear Rough Service, LED

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: VAP 4000LM FST MD MVOLT GZ10 40K 80CRI

VAP							
Series	**Nominal lumens**	**Diffuser**	**Distribution**	**Voltage**	**Driver**	**Color temperature**	**CRI**
VAP	4000LM 4,000 lumens	FST Frosted polycarbonate lens	MD Medium	MVOLT 120/277V	GZ10 0 - 10V dimming	30K 3000K	80CRI 80 CRI
	6000LM 6,000 lumens	PCL Clear polycarbonate lens	WD Wide	120 120V		35K 3500K	90CRI 90 CRI
	8000LM 8,000 lumens[1]			277 277V		40K 4000K	
	12000LM 12,000 lumens[1,2,3]			HVOLT 357/480V		50K 5000K	
	15000LM 15,000 lumens[1,3,4,5]			347 347V			
				480 480V			

PROVIDE EMERGENCY BATTERY PACK WHERE INDICATED AS EMERGENCY FIXTURE ON PLAN

Options

BSL520	Bodine® emergency LED battery pack for -20°C and up, CA Title 20 Noncompliant[4,5,6,7]	STSL	Stainless steel tamper resistant latches	Individual Controls:[7,8,15]	
E15WCP	Emergency battery pack, 15W constant power, Certified in CA Title 20 MAEDBS[4,6,7,8,9]	QMB	Quick-mount ceiling bracket	MSI10NWL	Low mount 360 integral motion sensor, wet location, On/Off operation
WLF	Wet location fitting (two outboard, top)[10]	CMB	Chain-mount suspension bracket	MSI102L3VWL	Low mount 360 integral motion sensor, wet location, High/Low operation (bi-level)
WLFIN	Wet location fitting (two inboard, top)[10]	JSB	Junction box snap-bracket	MSI10NWL DSCNWL	Low mount 360 integral motion sensor, wet location, On/Off operation for motion sensing, override Off due to daylight
WLFEND	Wet location fitting (one end)	LSC	Lens safety clip	Xpoint Wireless:[15]	
WLFEND2	Wet location fitting (both ends)[10,11]	DL	Damp location	XAD	XPoint™ wireless controller ,0-10V dimming[4,7,13]
CS89	6' white cord, 16/3, no plug, wet location[12]	BGTD	Bodine generator transformer device[4,7,8,13]	MSI10XAWL10M DSCXAWL	XPoint™ wireless integral motion sensor, On/Off operation for motion sensing, override Off due to daylight[8]
CS88	6' Brad Harrison 16/3 cord and straight blade plug set[8]	SF	Single fuse (120, 277, 347V)	nLight Air2:	
CS88L12	12' Brad Harrison 16/3 cord and straight blade plug set[8]	DF	Double fuse (208, 240, 480V)	NLTAIR2 RSBOR10	nLight AIR generation 2 enabled 360 low mount motion sensor[7,8,14]
		SPD	Surge protection device[14]		

PROVIDE STEM MOUNTING. LENGTH AS REQUIRED PER BOTTOM OF FIXTURE MOUNTING HEIGHT.

Accessories: *Order as separate catalog number. (Ships separately)*

VAPSMB	Surface-mount bracket	RK1 T20BIT	Hex base driver bit, Torx T20 Tamper resistant screws with center reject pin
VAPQMB	Quick-mount ceiling bracket	RK1 T20DRV	Torx T20 screwdriver for use with tamper resistant screws with center reject pin
VAPCMB	Chain-mount bracket		
VAPJSB	Junction box snap bracket		
HC36	Wire hook and 36" chain set[16,17]		

Notes

1 Not available with BSL520 battery option
2 When used with XAD, HVOLT, 347 and 480, maximum ambient temperature is 35°C.
3 Not available with E15WCP.
4 Not available with HVOLT, 347 and 480.
5 Maximum ambient temperature 35°C.
6 Not available with XPoint options.
7 Not available with SPD as the SPD is standard with option.
8 Must specify voltage.
9 Minimum ambient temperature is 0°C. Title 20 compliant. Maximum mounting height is 25ft.
10 Utilizes 5/8" long NPT threaded hub.
11 Not available with cord, sensor or photocell options.
12 Fixtures ship with black 4-conductor cords when BSL520 options are ordered.
13 If used with 8000LM, 12000LM or 15000LM, maximum ambient temperature is 35°C.
14 For additional protection up to 10kV.
15 Not available with multiple control options - other MSE or Xpoint.
16 Requires CMB (chain mount bracket) option.
17 For stainless steel, specify STS (ex. HC36 STS).

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-7378 www.lithonia.com
 Rev. 04/16/2019

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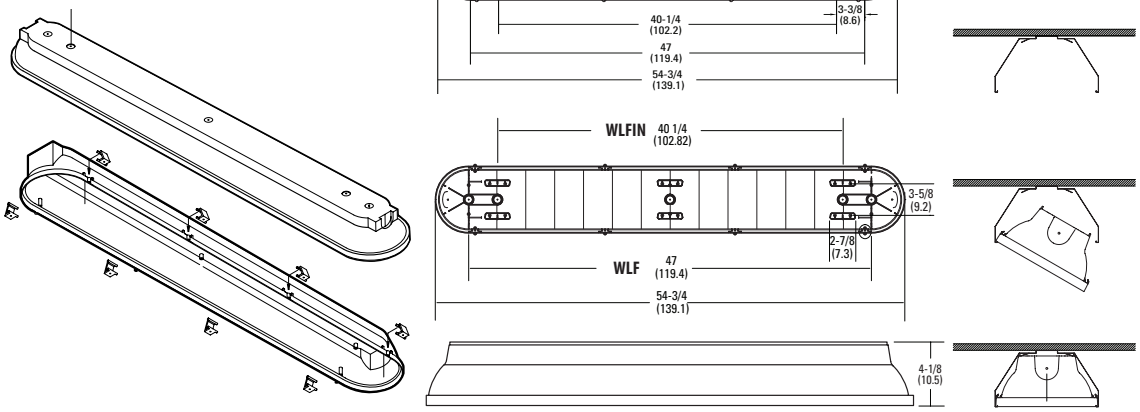
VAP Linear Rough Service, LED

DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

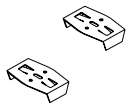
Specifications subject to change without notice.



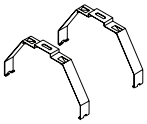
MOUNTING ACCESSORIES

CMB - Chain Mounting Brackets

JSB - Junction Box Mounting Bracket



QMB - Quick-Mount Mounting Brackets



SMB - Surface Mount Brackets (ship with fixture as standard)

ARCHWAY™ PASSAGE™ LED Specification Matrix											
Nominal lumens	Distribution	Initial delivered lumens @ 80CRI with clear polycarbonate lens				Initial delivered lumens @80CRI with frosted polycarbonate lens				Wattage @120V	Comparable source
		30K	35K	40K	50K	30K	35K	40K	50K		
4000LM	MD	4295	4446	4517	4647	3695	3777	3887	3998	33	2-lamp 32W T8, 1-lamp 54W T5, 70W HID
	WD	4208	4357	4426	4553	3623	3750	3810	3919		
6000LM	MD	6013	6226	6325	6506	5174	5357	5443	5598	49	3-lamp 32W T8, 2-lamp 54W T5, 100W HID
	WD	5892	6100	6198	6375	5072	5251	5335	5488		
8000LM	MD	8348	8643	8781	9032	7183	7437	7556	7772	67	4-lamp 32W T8, 2-lamp 54W T5, 150W HID
	WD	8180	8469	8604	8850	7042	7290	7407	7618		
12000LM	MD	11742	12156	12350	12703	10103	10460	10627	10931	99	6-lamp 32W T8, 3-lamp 54W T5, 250W HID
	WD	11505	11911	12101	12447	9904	10254	10417	10715		
15000LM	MD	14519	15031	15271	15708	12493	12934	13140	13516	115	6-lamp 32W T8, 4-lamp 54W T5, 250W HID
	WD	14226	14728	14963	15391	12246	12679	12881	13249		

Lumen Mantenance @ 25C

Operating Hours	0	10,000	20,000	25,000	35,000	50,000	60,000	75,000	100,000
4000LM	1	0.980	0.973	0.969	0.962	0.952	0.95	0.935	0.919
6000LM	1	0.972	0.962	0.957	0.950	0.933	0.923	0.909	0.886
8000LM	1	0.962	0.947	0.94	0.925	0.903	0.889	0.868	0.834
12000LM	1	0.970	0.960	0.952	0.940	0.922	0.910	0.900	0.865
15000LM	1	0.969	0.956	0.949	0.936	0.917	0.905	0.886	0.857

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-7378 www.lithonia.com

 Rev. 04/16/2019

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VAP Linear Rough Service, LED

OPTIONS AND ACCESSORIES

The DMW2 Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

rSBOR/SBOR – Fixture Mount Sensor (see www.sensorswitch.com for additional information)

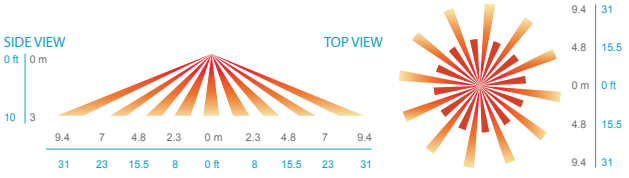
- 360° coverage
- On/Off dim
- Photocell optional
- IP66 rated
- Photocell and 0-10VDC dimming options.

Fixture sensor nomenclature	RSBOR/SBOR sensor nomenclature
For shortest lead times use one of the following SBOR configurations	
NLTAIR2 RSBOR10	RSBOR 10 EB4 WH G2
MSI10NWL	SBOR 10 OEX EB4 WH
MSI102L3VWL	SBOR 10 OEX D EB4 WH 3V
MSI10NWL DSCNWL	SBOR 10 OEX P EB4 WH

COVERAGE PATTERNS

PARKING GARAGE / LOW MOUNT APPLICATIONS

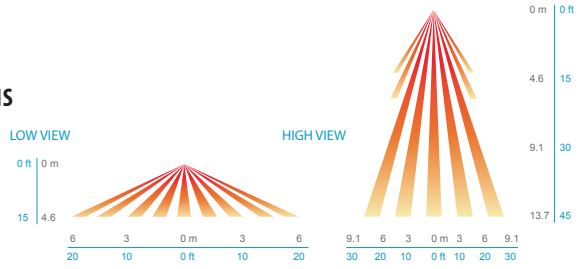
In general, the SBOR 10 is recommended for 8-15 ft (2.44-4.57 m) mounting and provides a coverage area radius for walking motion of greater than 2x the mounting height. The SBOR 10 ODP is ideal for parking garage and low pole mount applications. When mounted 10 ft high, for example, on a luminaire in a parking garage, the sensor's coverage for walking motion extends out 30 ft in a 360º pattern. This closely matches the lighting distribution of a typical parking garage luminaire. When mounted to a light pole, for example, in a parking lot or along a path, the sensor provides 270º of coverage (90º is blocked by the pole). Note, walking askew to sensor typically results in earlier detection than walking directly at sensor.



Coverage Pattern of Low Mount Lens Option (SBOR 10)

SITE & AREA LIGHTING / HIGH MOUNT APPLICATIONS

The SBOR 6 is intended for higher pole mount applications, between 15-30 ft (4.57-9.14 m), and provides a coverage area radius for walking motion of 15-20 ft (4.57-6.10 m). When mounted to a pole the sensor provides 270º of coverage (90º is blocked by the pole).



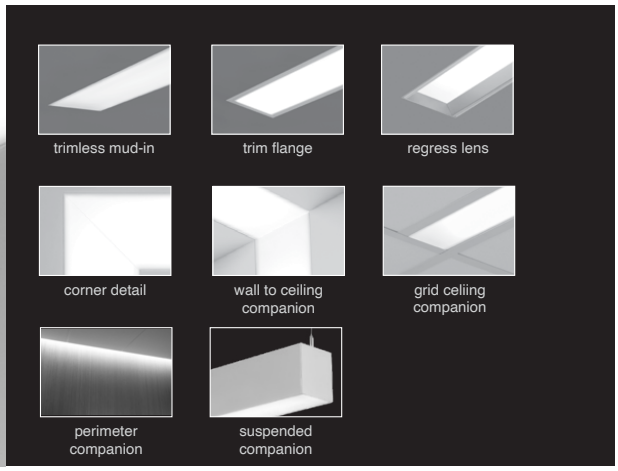
Coverage Pattern of High Mount Lens Option (SBOR 6)

L9

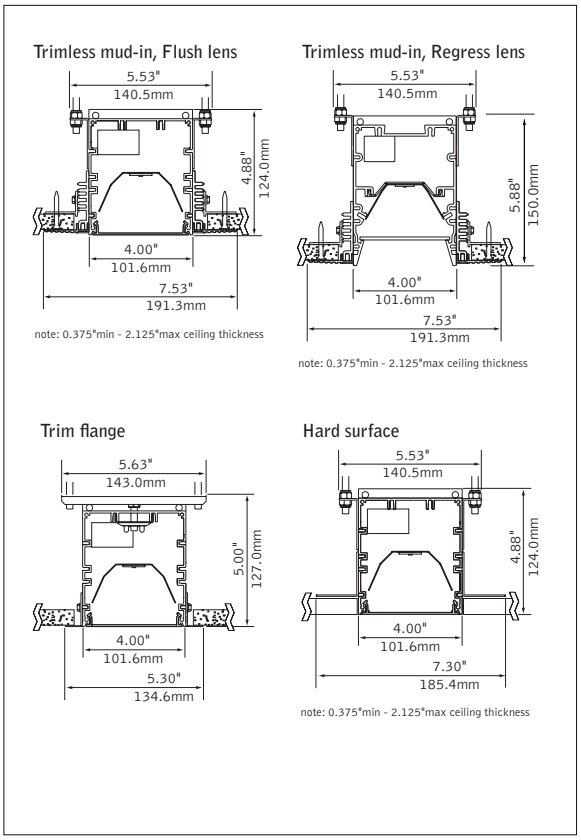
Seem® 4 Drywall/Hard Ceiling

LED

FOCAL POINT



DIMENSIONAL DATA



FEATURES

Extruded aluminum 4" aperture recessed slot LED integrates with drywall or hard ceilings or walls in a variety of mounting styles for a clean, unobtrusive aesthetic.

Individual units and continuous runs in 1" increments.

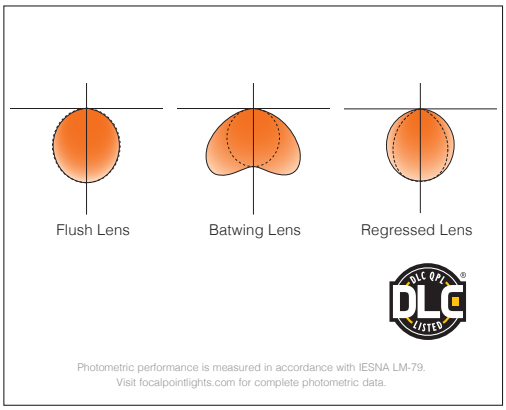
Frosted acrylic lens provides uninterrupted illumination, without pixels or shadows.

LED position and lens material optimized to provide the perfect blend of high performance and visual comfort.

Preferred Light: Lighting for better color rendition and human preference.

PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires.

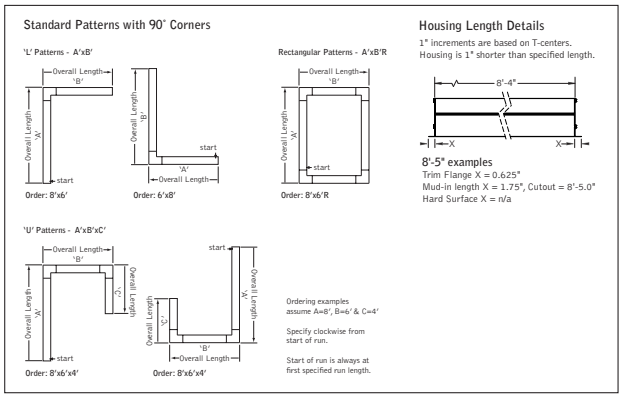
PERFORMANCE



Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

fixture: project:

DETAILS



SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with CRI>80 or CRI>90, 3 SDCM. 3500K and 4000K with CRI>90 have a cyanosis observation index (COI) of 3.3 or less. LED modules and drivers are replaceable from below.

Construction

One piece extruded aluminum housing. 20 Ga. steel end caps. Housing for new construction applications. XFW acceptable for use with wood, consult factory for Type IC availability. 2' unit weight: 12 lbs., 3' unit weight: 16 lbs., 4' unit weight: 20 lbs., 5' unit weight: 24 lbs.

Optic

Reflectors fabricated of 22 Ga. steel finished in High Reflectance White powder coat. Extruded acrylic lens .085" thick with satin finish, up to 8' continuous.

Electrical

Luminaires are pre–wired with factory installed branch circuit wiring and over-molded quick connects. Standard 120-277V constant current driver includes 0-10V analog dimming. Power factor >.9. PoE compatible: Integrates with Power over Ethernet lighting systems via standard, low-voltage wires. PoE runs require an independent PoE node and power feed for each luminaire section.

Emergency

Output - 10 watts for 90 minutes. Maximum mounting height: 19.2ft.
See EM/EC Guide for default locations and ordering details.

Labels

UL and cUL listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre–treatment.

Lumen Maintenance

Reported: L70 > 61,000 hours
L90 > 61,000 hours
Calculated: L70 at > 480,000 hours
L90 at > 128,000 hours
(Derived from EPA T M-21 calculator. Based on typical conditions, consult factory for additional data.)

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty

LED system rated for operation in ambient environments up to 25°C. 5-year limited warranty.

4' PERFORMANCE CHART

See page 3.

WHERE INDICATED ON LIGHTING PLAN

REFER TO LIGHTING PLAN FOR LENGTHS. COORDINATE WITH ARCHITECT.

QS 10 DAY

Options in orange qualify for the Quickship program. 1000' total, 48' maximum per pattern section. Refer to Quickship Guide for complete details including EM/EC options.

L9

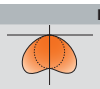
ORDERING

Luminaire Series		**FSM4L**
Seem 4 LED	FSM4L	
Shielding		
Batwing Lens	BW	
Flush Satin Lens	FL	
Regress Lens (Ceiling applications only)	SR	
Regress High Performance Lens (Ceiling applications only)	SRXP	
Lumen Output		
275 Lumens per foot (Not available with Lutron Drivers.)	275LF	
375 Lumens per foot (Not available with LU5 & LH1 Drivers)	375LF	
625 Lumens per foot (BW, FL & SR 3' minimum with LU5 & LH1 Drivers. SRXP 4' minimum with LU5 & LH1 Drivers.)	625LF	
875 Lumens per foot (SR & SRXP 3' minimum with LU5 & LH1 Drivers)	875LF	
1000 Lumens per foot	1000LF	
1125 Lumens per foot	1125LF	
1250 Lumens per foot	1250LF	
Color Temperature		
2700K, 80+ CRI **or** 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 90+ CRI	40K **or** 940K	
3500K, Preferred Light (BW & FL Lens only. 6" increments. Patterns not available.)	P35K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
UNV 120/277 Volt	UNV	
Low Voltage	LV	
Control System & Dimming Level		
0-10V - 10% Dimming	LD1	
0-10V - 1% Dimming	L11	
Low Voltage, PoE compatible (No driver. Not available with EM or EC. LV Voltage only.)	LVN	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
Lutron 5-Series EcoSystem (LDE5) - 5% Dimming	LU5	
DALI 1% Dimming (1000LF max.)	D11	
Ceiling Configuration		
Trim Flange Drywall (3' minimum with Lutron Drivers)	TF	
Trim Flange Wood (3' minimum with Lutron Drivers)	TFW	
Mud-in Trimless, pre-set for 1/2" Drywall	XF1	
Mud-in Trimless, pre-set for 5/8" Drywall	XF2	
Mud-in Trimless, set thickness in field (Mounting equipment assembled in field)	XFF	
Non-Drywall Hard Surface	XFN	
Hard Surface, Wood	XFW	
Factory Options		
Chicago Plenum	CP	
Emergency Circuit (4' minimum.)	_EC	
Emergency Battery Pack (4' minimum. Not available at corners. See EM/EC Guide for default locations and ordering details.)	_EM	
6' New York City Flex Whip (120V)	FNY1	
6' New York City Flex Whip (277V)	FNY2	
6' Flex Whip	FW	
Finish		**WH**
Matte White Housing	WH	
Luminaire Length		**ft in**
Specify luminaire/row length in 1" increments (2' minimum, lengths are nominal 1" increments based on T-centers. Housing length is 1" shorter than specified. Leave blank for patterns. Smaller increments available, consult factory.)	_ft _in	
Pattern Options (3' minimum length)		
'L' pattern	A' x B'	
'U' pattern	A' x B' x C'	
Rectangular pattern (Consult factory for other pattern options)	A' x B' R	

For more information visit focalpointlights.com/reference or consult factory.

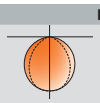
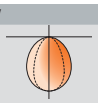
L9

4' PERFORMANCE CHART

			LPW	
Lumens Output	Delivered Lumens	Tested System Watts	 BW	 FL
275	1100	10	104	100
375	1500	13	113	108
625	2500	22	112	107
875	3500	32	109	105
1000	4000	37	109	104
1125	4500	44	108	104
1250	5000	49	107	102

Based on 3500K, 80 CRI, 4' lengths. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

4' PERFORMANCE CHART - REGRESS

			LPW	
Lumens Output	Delivered Lumens	Tested System Watts	 SR	 SRXP
275	1100	12	79	98
375	1500	16	84	109
625	2500	26	84	110
875	3500	39	80	105
1000	4000	46	77	101
1125	4500	53	76	101
1250	5000	59	75	99

Based on 3500K, 80 CRI, 4' lengths. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

L10

Catalog Number	
Notes	
Type	

EPANL LED

1'x4', 2'x2', and 2'x4'

DIGITAL NAVIGATION
Ordering Tree nLight Platform Sensor Switch JOT Photometrics Performance Data Drawings

FEATURES & SPECIFICATIONS

INTENDED USE — The EPANL Series LED Edge-Lit Flat Panel provides a fully luminous appearance across the face of the lens. This provides a soft, glare-free solution that is visually comfortable within the space. Suitable for many lighting applications including schools, offices and other commercial spaces, retail, convenience stores, hospitals and healthcare facilities. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.**

CONSTRUCTION — This edgelit platform was built to last with an aluminum frame for strength and durability, the seamless frame prevents light leak in the corners. The PMMA light guide plate and lens resists yellowing and transmits light with superior efficacy. The satin white lens provides excellent shielding and fully luminous appearance. EPANL's low-profile design provides increased installation flexibility especially in restricted plenum spaces. The back plate includes integral T-bar clips for installation into 15/16" or 9/16" T-grid ceilings. Fixture may be recessed, suspended, surface box mounted or mounted in a hard-ceiling see accessories section for more information. Fixture may be mounted and wired in continuous rows.

Integrated Sensor (nLight Wired Networking): This sensor is nLight-enabled, meaning it has the ability to communicate over an nLight network. When wired, using CAT-5 cabling, with other nLight-enabled sensors, power packs, or WallPods, an nLight control zone is created. Once linked to a Gateway, directly or via a Bridge, the zone becomes capable of remote status monitoring and control via SensorView software.

Integrated Smart Sensor (nLight Air Wireless Platform): The RES7 sensor is nLight AIR enabled, meaning it has the ability to communicate over the wireless nLight control platform. It is available with an automatic dimming photocell, and either a digital PIR or a microphonics (PDT) dual technology occupancy sensor. It pairs to other luminaires and wall switches through our mobile app, CLAIRITY+, which allows for simple sensor adjustment.

Integrated Wireless Sensor (single room control): Sensor Switch VERTEX JOT or JOTVTX15 luminaire-embedded occupancy and ambient light sensor allows the luminaire to power off when the space is unoccupied or when enough ambient light is entering the space. See page 7 for more details on the integrated wireless sensor.

ELECTRICAL — Long-life LEDs, coupled with a high-efficiency driver, provide superior illumination for extended service life. See page 3 for detailed lumen maintenance information. 0-10V dimming driver, dims to 1% or 10% and contains non-isolated dimming leads.

LISTINGS — CSA Certified to meet US and Canadian standards. Tested to meet UL1598. Intended for indoor use only. Product is not to be stored in non-climate controlled spaces.

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.

Damp location listed. IC rated. IP5X rated. Long nomenclature, configurable product is rated for NSF/ANSI Standard 2 - Light Fixture for Splash Zone and Non Food Zone. Tested in accordance with ISO 14644-1; suitable for ISO Class 5–9 positive and negative pressure clean rooms. Suitable for ambient temperatures from 32°F (0°C) to 77°F (25°C).

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.

Dimensions

	1x4	2x2	2x4
Length	47.72"	23.70"	47.72"
Width	11.85"	23.70"	23.70"
Depth	2.19"	2.19"	2.19"
Weight	13.9 lbs	7.4 lbs	15.1 lbs

* Base configurations; options may add weight

Embed nLight controls today. Prepare for tomorrow.

Now	Tomorrow
User-friendly install	Scalability
Enhanced energy savings	Space configuration
Code compliance	Future-ready

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

L10

EPANL LED Flat Panel

A+ Capable options indicated by this color background.

ORDERING INFORMATION

Example: EPANL 2X4 4000LM 80CRI 35K MIN1 MVOLT E10WCP NLTAIR2 RIO

Series	Width and Length	Lumens		CRI	Color Temperature	Minimum Dimming Level ‡
		Standard Lumens:	High Efficiency Lumens:			
EPANL LED Flat Panel	1x4 1'x4'	1500LM 1500 Lumens	1500LMHE 1500 Lumens	80CRI 80 CRI	30K 3000K	MIN10 Dims to 10% ‡
		3000LM 3000 Lumens	3000LMHE 3000 Lumens		35K 3500K	MIN1 Dims to 1%
		4000LM 4000 Lumens	4000LMHE 4000 Lumens		40K 4000K	
		4800LM 4800 Lumens	4800LMHE 4800 Lumens		50K 5000K	
		6000LM 6000 Lumens	6000LMHE 6000 Lumens			
	2x2 2'x2'	2000LM 2000 Lumens	2000LMHE 2000 Lumens			
		3400LM 3400 Lumens	3400LMHE 3400 Lumens			
		4000LM 4000 Lumens	4000LMHE 4000 Lumens			
		4800LM 4800 Lumens	4800LMHE 4800 Lumens			
	2x4 2'x4'	3000LM 3000 Lumens	3000LMHE 3000 Lumens			
		4000LM 4000 Lumens	4000LMHE 4000 Lumens			
		4800LM 4800 Lumens	4800LMHE 4800 Lumens			
		5400LM 5400 Lumens	5400LMHE 5400 Lumens			
		6000LM 6000 Lumens	6000LMHE 6000 Lumens			
		6800LM 6800 Lumens	6800LMHE 6800 Lumens			
		7200LM 7200 Lumens	7200LMHE 7200 Lumens			

Dimming ‡	Voltage	Step Level Dimming	Emergency Option
ZT Generic 0-10V Dimming	MVOLT 120-277V	(Blank) None	E10WCP EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS ‡
EZT eldoLED 0-10V Dimming	120 120V	SLD Step Level Dimming ‡	GTD Generator Transfer Device ‡
DALI eldoLED DALI	277 277V		EMG for use with NLIGHT or NLTAIR2 on generator supply EM power ‡
	347 347V ‡		

Control Options

Control Input

nLight Wired:

NLIGHT	nLight enabled, no constant lumen management
CL80 NLIGHT	nLight enabled, constant lumen output 80%

nLight Wireless:

NLTAIR2	nLight AIR Generation 2 enabled ‡

Control

nLight Wired: ‡

(blank)	no control

nLight Wireless:

RIO	nLight AIR Radio module without sensor ‡
RES7	nLight AIR control with PIR integral occupancy sensor and automatic dimming photocell ‡
RES7PDT	nLight AIR control with PDT dual technology integral occupancy sensor and automatic dimming photocell ‡

Individual Control

JOT	Wireless room control with "Just One Touch" pairing ‡
JOTVTX15	Wireless occupancy sensor with "Just One Touch" pairing ‡

Options

GLR	Fast-blowing fuse ‡
GMF	Slow-blowing fuse ‡
PWS1836	6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit
PWS1846	6' pre-wire, 3/8" diameter, 18 gauge, 2 circuit
PWS1846 PWSLV	Two cables: one 6' pre-wire, 3/8" diameter, 18 gauge, 2 circuits; one 6' pre-wire, 3/8" diameter, 18 gauge ‡
PWS1856LV	6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit w/low voltage wires ‡
CP	Chicago plenum ‡
NPLT	Narrow Pallet
BDP	Factory Installed Ballast Disconnect Plug
RRL_	RELOC®-ready luminaire ‡

NOTE: ‡ indicates option value has ordering restrictions. Please reference the Option Value Ordering Restictions chart on the next page. Options are sorted alphanumerically.

EPANL LED Flat Panel

L10

‡ Option Value Ordering Restrictions	
Option Value	**Restriction**
347	Not available with SLD, E10WCP, or GTD options.
Dimming	If Step Level Dimming (SLD) or NLIGHT or NLTAIR2 is specified, leave this section blank.
CP	Not available with nLight wired (NLIGHT), nLight wireless (NLTAIR2). Not available with PWS1836, PWS1846, PWS1856LV, or PWS1846 PWSLV.
E10WCP	Refer to Emergency Battery Estimated Lumen section for lumen estimation. Test Switch must be remote mounted or installed in an adjacent ceiling tile. When using pre-wire option, use PWS1846 or PWS1846 PWSLV.
EMG	Requires a connection to existing NLIGHT or NLTAIR2 network. Power is provided from separate nLight enabled fixture. When EMG is combined with NLTAIR2 see UL924 Sequence of Operation Chart on page 4.
GLR, GMF	Must specify voltage. 120 or 277, with GLR and GMF fusing.
GTD	Not available with JOT, JOTVTX15, sensor options or emergency battery options. Must specify voltage. Requires BSE labeling, voltage specific. Consult factory for options. Example: GTD BSE10.
JOT, JOTVTX15	Not available with NLIGHT, DALI, SLD, GTD, EMG, or NLTAIR2 options.
MIN10	Not available with EZT, NLIGHT or DALI.
Minimum Dimming Level	If Step Level Dimming (SLD) is specified, leave this section blank.
NLTAIR2	Only available with MIN1 minimum dimming level option.
PWS1846 PWSLV	Not available with GTD, nLight wired, nLight wireless, NLIGHT or NLTAIR2.
PWS1856LV	Not available with nLight wired, nLight wireless, NLIGHT, or NLTAIR2.
RES7, RES7PDT, RIO	See UL924 Sequence of Operation chart on page 4. Can be used as a normal power sensing device for nLight Air devices and luminaries with EM options.
RRL_	For ordering logic consult RRL_2013.
SLD	Not available with with any nLight Interface, Control options, or GTD. When using prewire option use PWS1846.

Tunable White (Select SKUs Only)

Available SKUs:

*2735H0 EPANL 2X2 TUWH PROR 4800LM 80CRI NLT
*2735H9 EPANL 2X2 TUWH PROR 4800LM 80CRI NLT PWS1836
*2735HJ EPANL 2X2 TUWH PROR 4800LM 80CRI NLT E10WCP
*2735HN EPANL 2X2 TUWH PROR 4800LM 80CRI NLT E10WCP PWS1846

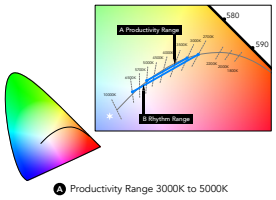
Operating Performance:

Nomenclature	CCT	Lumens	Efficacy	CRI
EPANL 2X2 TUWH PROR 4800LM 80CRI NLT @ 3000K	3105	4527.53	98.81	80.78
EPANL 2X2 TUWH PROR 4800LM 80CRI NLT @ 4000K	3974	4920.24	127.2	83.85
EPANL 2X2 TUWH PROR 4800LM 80CRI NLT @ 5000K	4925	5004.18	123.41	82.89

Mainstream Dynamic Tunable White with nTune Technology: Tunable white nTune™ is an all-digital light color temperature control within an nLight enabled luminaire. This brings tunable white lighting control into the mainstream with repeatable, consistent results in an economical luminaire form and system already familiar to schools. Designers and facility operators are granted the freedom to tie scenes to specific activities or to complement colors or materials within a visual environment. nTune™ allows color temperature settings through the Productivity Range of 3000K-5000K. Refer to the Programming User's Guide for instructions on customizing to your application with SensorView.

Tunable White GPHD

- **Gamut**: One dimensional Warm-Cool
- **Path**: Direct 3000K to 5000K (Productivity Range)
- **Handle**: Two Natural Language Handles: Intensity and CCT
- **Data**: nLight with nTune technology for both handles of control



Ⓐ Productivity Range 3000K to 5000K

Lumen Maintenance:

EPANL	Reported Lumen Maintenance	Forecasted Lumen Maintenance
SE LEDs	L90 @ 41k Hrs / L80 @ >54k Hrs / L70 @>54k Hrs	L90 @ 41k Hrs / L80 @ 84k Hrs / L70 @ 134k Hrs
HE LEDs	L90 @ 44k Hrs / L80 @ >54k Hrs / L70 @ >54k Hrs	L90 @ 44k Hrs / L80 @ 93k Hrs / L70 @ 148k Hrs

COMMERCIAL INDOOR: One Lithonia Way Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.acuitybrands.com

Rev. 11/21/22

L10

EPANL LED Flat Panel

ACCESSORIES

Accessories: *Order as separate catalog number.*	
DGA14	Drywall grid adapter for 1x4 recessed fixture.
DGA22	Drywall grid adapter for 2x2 recessed fixture.
DGA24	Drywall grid adapter for 2x4 recessed fixture.
PANLEM E10WCP BKT CVR	Field installable kit includes 10 watt battery, bracket and cover [1]
PANLEM BKT CVR	Field installable kit bracket and cover only, 10W battery NOT included [1]
2X2SMKSH	2'x2' Surface Mount Troffer Kit
2X4SMKSH	2'x4' Surface Mount Troffer Kit
1X4SMKSH	1'x4' Surface Mount Troffer Kit
BDP U	Field Installable Ballast Disconnect Plug
PAC 2DNF 36	Panel Air Craft Kit, 2 cables with Y splitter, No Power Feed, 36 inches. Recommended for 1X4 or 2X2 Panel Fixtures only.[2]
PAC 2DF 36	Panel Air Craft Kit, 2 cables with Y splitter, with Power Feed, 36 inches. Recommended for 1X4 or 2X2 Panel Fixtures only.[2,3]
PAC 4DNF 36	Panel Air Craft Kit, 4 cables, No Power Feed, 36 inches. Recommended for 2X4, 1X4 or 2X2 Panel Fixtures.[2]
PAC 4DF 36	Panel Air Craft Kit, 4 cables, with Power Feed, 36 inches. Recommended for 2X4, 1X4 or 2X2 Panel Fixtures.[2,3]
PAC 2DNF 72	Panel Air Craft Kit, 2 cables with Y splitter, No Power Feed 72 inches. Recommended for 1X4 or 2X2 Panel Fixtures only.[2]
PAC 2DF 72	Panel Air Craft Kit, 2 cables with Y splitter, with Power Feed, 72 inches. Recommended for 1X4 or 2X2 Panel Fixtures only.[2,3]
PAC 4DNF 72	Panel Air Craft Kit, 4 cables, No Power Feed, 72 inches. Recommended for 2X4, 1X4 or 2X2 Panel Fixtures.[2]
PAC 4DF 72	Panel Air Craft Kit, 4 cables, with Power Feed, 72 inches. Recommended for 2X4, 1X4 or 2X2 Panel Fixtures.[2,3]

Emergency Battery Estimated Lumens

Use the formula below to estimate the delivered lumens in emergency mode

Estimated Lumens = 1.25 x P x LPW

P = Output power of emergency driver (10W for PS1055CP)

LPW = Lumen per watt rating of the luminaire.

SMKSH Accessory

Notes:
1. Test switch must be remote mounted or installed in an adjacent ceiling tile.
2. See Suspension Kits section below for additional detail.
3. For MVOLT only, not available with 347V

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
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.

UL 924 Response – nLight AIR Devices with EM Option

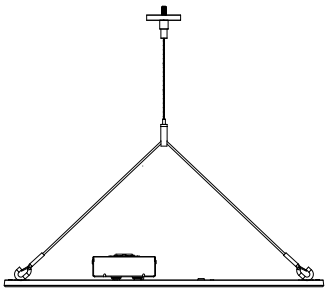
The below information applies to all nLight AIR devices with an EM option.

- 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.

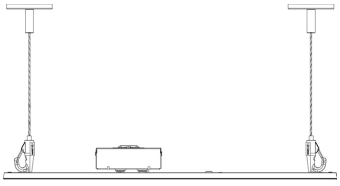
Suspension Kits

2 drops (1x4)

2 drops (2x2)



4 drops (2x4)



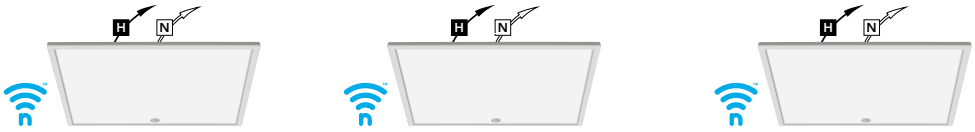
EPANL LED Flat Panel

L10

nLight Platform

nLight embedded fixtures offer:	Customers get:
Manual Dimming	Convenience and visual comfort for occupants
Motion Sensing and/or Daylight Harvesting	Energy savings and code compliance
Fixture or Group Level Control	Ability to configure lighting to the space requirements
Flexibility	Ease of fixture moves, adds and changes
Wireless Wall Switch (nLight AIR Only)	Ease and flexibility of placement
Astronomical and Time of Day Scheduling	Energy savings and building security
Scalable Solution	nLight controls to grow with your business
Future-Ready	nLight platform to set foundation for future upgrades and capabilities

nLight Air Wireless



EPANL

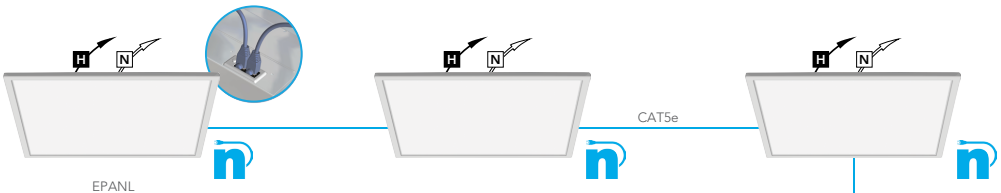
Simple as 1,2,3

1. Install the nLight® AIR fixtures with embedded smart sensor
2. Install the wireless battery-powered wall switch
3. With the CL***AIR***ITY+ Pro app, pair the fixtures with the wall switch and if desired, customize the sensor settings for the desired outcome

nLight AIR rPODBA 2P DX G2

Mobile Device

nLight Wired Networking



EPANL

Simple as 1,2,3

1. Install the nLight® Wired fixtures with nIO control
2. Install the nLight Wired wall switch
3. Connect the fixtures using standard CAT5e cables and the devices will automatically discover each other and work (plug and play)

nLight Wired nPODM 2P DX

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EPANL LED Flat Panel

Controls Accessories

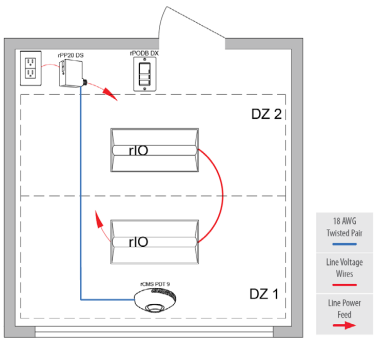
nLight® Wired Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlight.

WallPod stations	Model number	Occupancy sensors	Model number
On/Off	nPODMA [Color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 RJB / nCM PDT 9 RJB
On/Off & raise/lower	nPODMA DX [Color]	Large motion 360°, ceiling (PIR / dual tech)	nCM10 RJB / nCM PDT 10 RJB
Graphic touchscreen	nPOD TOUCH [Color]	Wall switch with raise/lower	nWSX PDT LV DX [color]
Photocell controls	**Model number**	**Cat-5 cable (plenum rated)**	**Model number**
Full range dimming	nCM ADCX RJB	10' cable	CAT5 10FT J1
		30' cable	CAT5 30FT J1

nLight® AIR Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlightair.

Wall switches	Model number
On/Off single pole	rPODBA [color] G2
On/Off two pole	rPODB A2P [color] G2
On/Off & raise/lower single pole	rPODBA DX [color] G2
On/Off & raise/lower two pole	rPODBA 2P DX [color] G2

EPANL fixtures with integrated rIO devices complement any small office space. Pair them with an rCMS occupancy sensor and the space now has wireless occupancy sensing and dimming capability. For additional configuration options please consult with Tech Support.



rCMS[1] — **Example: RCMS PDT 10 AR G2**

Series / Detection	Power Supply[1]	Occupancy Detection	Lens (Required)	Operating Mode	Generation
RCMS nLight AIR occupancy and daylight sensor	[blank] Power Supply ordered separately PS 150 Standard 150 mA Power Supply	[blank] PIR Detection PDT Dual Tech PIR/ Microphonics	10 Large Motion/ Extended Range 360° 9 Small Motion/ Extended Range 360° 6 High Bay 360° Lens	[BLANK] None AR Auxiliary Relay	G2 Generation 2 compatibility

Notes
1 RCMS requires low voltage power from either RPP20 DS 24V G2 or PS150.


Sensor Switch WSX


nLight WIRED NPOD UNITOUCH


nLight WIRED nPODMA DX


nLight AIR rPODBA


EPANL with rES7 **rPODBA** **RCMS**

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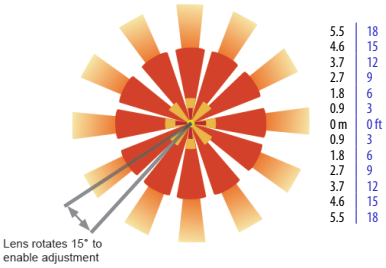
EPANL LED Flat Panel

Sensor Coverage Pattern
Mini 360° Lens

- Recommended for walking motion detection from mounting heights between 8 ft (2.44 m) and 20 ft (6.10 m)
- Initial detection of walking motion along sensor axes at distances of 2x the mounting height up to 15 ft (4.57 m) and
- 1.75x up to 20 ft (6.10 m).
- Provides 12 ft (3.66 m) radial detection of small motion when mounted at 9 ft (2.74 m)
- Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor

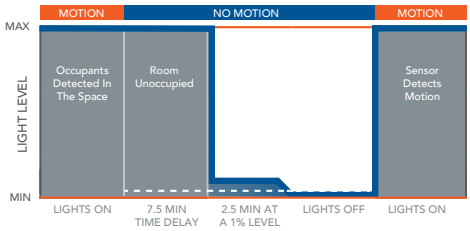
9 FT Mounting



nLight AIR Wireless

nLight AIR is the ideal solution for retrofit or new construction spaces where adding additional wiring can be labor intensive and nLight AIR is available with or without an integral sensor. The integrated rES7 or rES7PDT smart sensors are part of each luminaire in the nLight AIR network, which can be grouped to control multiple luminaires. The granularity of control with the digital PIR occupancy detection and daylight sensing makes a great solution for any application.

Sequence of Operation (nES7 and Sensor)



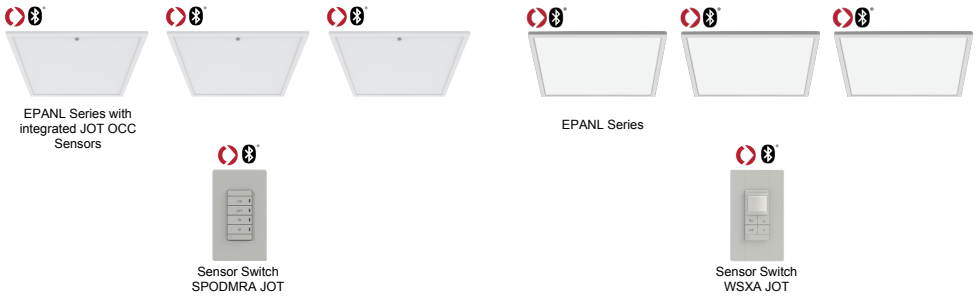
*The presetting on the automatic dimming photocell is 10fc (RES7).

Sensor Switch JOT

Sensor Switch JOT Enabled Wireless Solution

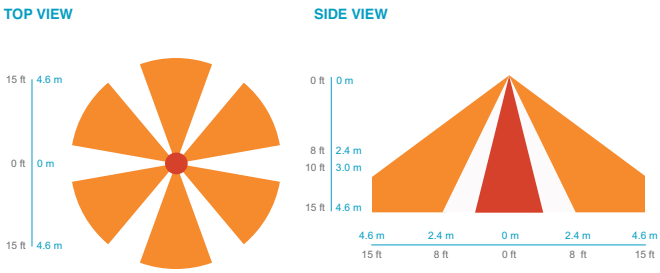
Designed with contractors in mind, the Sensor Switch JOT enabled wireless solution offers a straightforward approach to the installation and pairing of lighting fixtures and controls. Absolutely no 0-10V control wires and no mobile apps are needed with JOT enabled products, allowing for lightning speed installation right out of the box.

1. **Power:** Install JOT enabled fixtures and controls as instructed.
2. **Pair:** Insert the pairing tool into the pinhole on the wall switch; press and hold any button for 6 seconds.
3. **Play:** Once paired, each fixture will individually dim down to 10% brightness. All products will be fully functional.



15F - LARGE MOTION EXTENDED RANGE 360

- Optimized full coverage from 8 ft - 15 ft (2.4 m - 4.5 m) mounting heights
- Reliable detection of large motion (e.g. pedestrian walking traffic)
- 1.3 x mounting height equals approximate detection range



L10

EPANL LED Flat Panel

Performance Data					
Model No.	**DLC Classification**	**Lumens**	**Watts**	**LPW**	**DLC Product Id**
EPANL 1X4 1500LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1511	14	108	
EPANL 1X4 1500LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1511	14	108	
EPANL 1X4 1500LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	1574	14	113	PII6VKUP
EPANL 1X4 1500LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1574	14	113	
EPANL 1X4 1500LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	1637	14	117	P7MFGP4R
EPANL 1X4 1500LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1637	14	117	
EPANL 1X4 1500LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	1699	14	122	PS9YYB0V
EPANL 1X4 1500LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1699	14	122	
EPANL 1X4 1500LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1419	12	119	
EPANL 1X4 1500LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1419	12	119	
EPANL 1X4 1500LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1457	12	122	
EPANL 1X4 1500LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1457	12	122	
EPANL 1X4 1500LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1508	12	127	
EPANL 1X4 1500LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1508	12	127	
EPANL 1X4 1500LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1543	12	130	
EPANL 1X4 1500LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1543	12	130	
EPANL 1X4 3000LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	2841	27	106	
EPANL 1X4 3000LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2841	27	106	
EPANL 1X4 3000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	2960	27	110	P5L7HREA
EPANL 1X4 3000LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2960	27	110	
EPANL 1X4 3000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3078	27	114	PICJQWDG
EPANL 1X4 3000LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3078	27	114	
EPANL 1X4 3000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3197	27	119	P4AJOGI1
EPANL 1X4 3000LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3197	27	119	
EPANL 1X4 3000LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	2771	23	123	
EPANL 1X4 3000LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2771	23	123	
EPANL 1X4 3000LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	2845	23	126	
EPANL 1X4 3000LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2845	23	126	
EPANL 1X4 3000LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	2945	23	130	
EPANL 1X4 3000LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2945	23	130	
EPANL 1X4 3000LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3012	23	133	
EPANL 1X4 3000LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3012	23	133	
EPANL 1X4 4000LHME 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	3426	31	111	
EPANL 1X4 4000LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3659	37	100	
EPANL 1X4 4000LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3659	37	100	
EPANL 1X4 4000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3811	37	104	
EPANL 1X4 4000LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3811	37	104	
EPANL 1X4 4000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3963	37	107	P4SKVRJP
EPANL 1X4 4000LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3963	37	107	
EPANL 1X4 4000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4116	37	111	PFCL13O0
EPANL 1X4 4000LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4116	37	111	
EPANL 1X4 4000LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3667	31	120	
EPANL 1X4 4000LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3667	31	120	
EPANL 1X4 4000LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3765	31	123	
EPANL 1X4 4000LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3765	31	123	
EPANL 1X4 4000LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3897	31	128	
EPANL 1X4 4000LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3897	31	128	
EPANL 1X4 4000LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3985	31	130	
EPANL 1X4 4000LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3985	31	130	
EPANL 1X4 4800LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4633	45	104	PVIRSOQB
EPANL 1X4 4800LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4633	45	104	
EPANL 1X4 4800LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4807	45	108	PIQUALNF
EPANL 1X4 4800LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4807	45	108	
EPANL 1X4 4800LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4923	45	110	PR3K6SHH
EPANL 1X4 4800LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4923	45	110	
EPANL 1X4 4800LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4967	45	111	PIS28T0X
EPANL 1X4 4800LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4967	45	111	
EPANL 1X4 4800LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4340	37	117	
EPANL 1X4 4800LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4340	37	117	
EPANL 1X4 4800LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4456	37	120	
EPANL 1X4 4800LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4456	37	120	
EPANL 1X4 4800LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4612	37	124	
EPANL 1X4 4800LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4612	37	124	
EPANL 1X4 4800LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4717	37	127	
EPANL 1X4 4800LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4717	37	127	
EPANL 1X4 5400LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5156	44	116	PKIBC75K

L10

EPANL LED Flat Panel

Performance Data					
Model No.	**DLC Classification**	**Lumens**	**Watts**	**LPW**	**DLC Product Id**
EPANL 1X4 5400LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5156	44	116	
EPANL 1X4 5400LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5272	44	119	PNX0E6ZR
EPANL 1X4 5400LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5272	44	119	
EPANL 1X4 5400LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5490	44	124	PF0BSKQD
EPANL 1X4 5400LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5490	44	128	
EPANL 1X4 5400LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5665	44	128	PEC0GL65
EPANL 1X4 5400LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5665	44	130	
EPANL 1X4 6000LM 80CRI 30K [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	5953	55	109	P5BGKZ54
EPANL 1X4 6000LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5953	51	117	P25AS4VV
EPANL 1X4 6000LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5953	51	117	
EPANL 1X4 6000LM 80CRI 35K [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	5997	55	110	P8R62RB3
EPANL 1X4 6000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5997	51	118	PEC0ZVXY
EPANL 1X4 6000LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5997	51	118	
EPANL 1X4 6000LM 80CRI 40K [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	6171	55	113	PC28H7F3
EPANL 1X4 6000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6171	51	121	PJ2LT8RF
EPANL 1X4 6000LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6171	51	121	
EPANL 1X4 6000LM 80CRI 50K [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	6240	55	114	PIY822O4
EPANL 1X4 6000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6240	51	123	PL6024K5
EPANL 1X4 6000LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6240	51	123	
EPANL 2X2 2000LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1988	19	106	
EPANL 2X2 2000LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1988	19	106	
EPANL 2X2 2000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	2071	19	110	P7I6D3WI
EPANL 2X2 2000LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2071	19	110	
EPANL 2X2 2000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	2154	19	115	PPTL71HY
EPANL 2X2 2000LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2154	19	115	
EPANL 2X2 2000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	2237	19	119	P0OY8NZ2
EPANL 2X2 2000LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2237	19	119	
EPANL 2X2 2000LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1856	16	119	
EPANL 2X2 2000LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1856	16	119	
EPANL 2X2 2000LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1906	16	123	
EPANL 2X2 2000LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1906	16	123	
EPANL 2X2 2000LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	1972	16	127	
EPANL 2X2 2000LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	1972	16	127	
EPANL 2X2 2000LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	2017	16	130	
EPANL 2X2 2000LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2017	16	130	
EPANL 2X2 3400LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3291	30	109	P2QQIV0K
EPANL 2X2 3400LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3291	30	109	
EPANL 2X2 3400LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3428	30	113	PQAFPPJ6
EPANL 2X2 3400LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	3428	30	113	
EPANL 2X2 3400LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3428	30	113	
EPANL 2X2 3400LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3566	30	118	PY8MM627
EPANL 2X2 3400LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	3566	30	118	PMKTPCS2
EPANL 2X2 3400LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3566	30	118	
EPANL 2X2 3400LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3703	30	122	PCRM0D2R
EPANL 2X2 3400LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3703	30	122	
EPANL 2X2 3400LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3198	27	121	PWJ6HVP3
EPANL 2X2 3400LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3198	27	121	
EPANL 2X2 3400LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3285	27	124	PBV78YXA
EPANL 2X2 3400LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3285	27	124	
EPANL 2X2 3400LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3399	27	128	PBMBSQA8
EPANL 2X2 3400LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3399	27	128	
EPANL 2X2 3400LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3477	27	131	PU32L41S
EPANL 2X2 3400LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3477	27	131	
EPANL 2X2 4000LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3804	37	104	
EPANL 2X2 4000LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3804	37	104	
EPANL 2X2 4000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3963	37	108	
EPANL 2X2 4000LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3963	37	108	
EPANL 2X2 4000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4121	37	110	PW004OLR
EPANL 2X2 4000LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4121	37	110	
EPANL 2X2 4000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4280	37	114	P2O6CXK4
EPANL 2X2 4000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	4280	37	114	
EPANL 2X2 4000LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4280	37	114	
EPANL 2X2 4000LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3874	33	118	
EPANL 2X2 4000LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3874	33	118	
EPANL 2X2 4000LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3978	33	121	
EPANL 2X2 4000LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3978	33	121	

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EPANL LED Flat Panel

Performance Data					
Model No.	**DLC Classification**	**Lumens**	**Watts**	**LPW**	**DLC Product Id**
EPANL 2X2 4000LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4117	33	125	
EPANL 2X2 4000LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4117	33	125	
EPANL 2X2 4000LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4211	33	128	
EPANL 2X2 4000LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4211	33	128	
EPANL 2X2 4800LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4558	45	102	
EPANL 2X2 4800LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4558	45	102	
EPANL 2X2 4800LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4729	45	106	
EPANL 2X2 4800LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4729	45	106	
EPANL 2X2 4800LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4843	45	109	PS2AC19A
EPANL 2X2 4800LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4843	45	109	
EPANL 2X2 4800LM 80CRI 50K [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	4886	45	110	
EPANL 2X2 4800LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4886	45	110	P89SURCD
EPANL 2X2 4800LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4886	45	110	
EPANL 2X2 4800LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4420	36	121	
EPANL 2X2 4800LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4420	36	121	
EPANL 2X2 4800LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4539	36	125	
EPANL 2X2 4800LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4539	36	125	
EPANL 2X2 4800LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4697	36	129	
EPANL 2X2 4800LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4697	36	129	
EPANL 2X2 4800LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4804	36	132	
EPANL 2X2 4800LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4804	36	132	
EPANL 2X4 3000LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3015	29	106	
EPANL 2X4 3000LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3015	29	106	
EPANL 2X4 3000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3141	29	110	P4PIGUFW
EPANL 2X4 3000LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3141	29	110	
EPANL 2X4 3000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3266	29	115	PSPB7FBG
EPANL 2X4 3000LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3266	29	115	
EPANL 2X4 3000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3392	29	119	PSL0A6G7
EPANL 2X4 3000LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3392	29	119	
EPANL 2X4 3000LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	2943	23	129	PNSQ2LMI
EPANL 2X4 3000LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2943	23	129	
EPANL 2X4 3000LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	2986	23	131	P84A41CZ
EPANL 2X4 3000LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	2986	23	131	
EPANL 2X4 3000LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3071	23	135	P0S68XSR
EPANL 2X4 3000LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3071	23	135	
EPANL 2X4 3000LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3114	23	137	PW2SY5X9
EPANL 2X4 3000LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3114	23	137	
EPANL 2X4 3760LMHE 80CRI 40K MIN10 ZT MVOLT NACV	Standard	3984	27	147	PQMB5PAR
EPANL 2X4 4000LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	3914	38	104	
EPANL 2X4 4000LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3914	38	104	
EPANL 2X4 4000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4077	38	108	PG2MHOZE
EPANL 2X4 4000LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4077	38	108	
EPANL 2X4 4000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4240	38	113	PNKUCIIA
EPANL 2X4 4000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	4240	38	113	
EPANL 2X4 4000LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4240	38	113	
EPANL 2X4 4000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4403	38	117	P94H4XFG
EPANL 2X4 4000LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4403	38	117	
EPANL 2X4 4000LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3874	31	123	PT1H08CF
EPANL 2X4 4000LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3874	31	123	
EPANL 2X4 4000LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	3930	31	125	P8VKRLEE
EPANL 2X4 4000LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	3930	31	125	
EPANL 2X4 4000LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4042	31	129	PW2KT9FQ
EPANL 2X4 4000LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4042	31	129	
EPANL 2X4 4000LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4098	31	130	PD7JL7CS
EPANL 2X4 4000LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4098	31	130	
EPANL 2X4 4800LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4817	45	107	
EPANL 2X4 4800LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4817	45	107	
EPANL 2X4 4800LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	4998	45	111	P8FFEBQH
EPANL 2X4 4800LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	4998	45	111	
EPANL 2X4 4800LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4998	45	111	
EPANL 2X4 4800LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5119	45	113	PL3AU798
EPANL 2X4 4800LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	5119	45	113	
EPANL 2X4 4800LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5119	45	113	
EPANL 2X4 4800LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5164	45	114	P8TD4A4V
EPANL 2X4 4800LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	5164	48	107	
EPANL 2X4 4800LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5164	45	114	

EPANL LED Flat Panel

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Performance Data					
Model No.	**DLC Classification**	**Lumens**	**Watts**	**LPW**	**DLC Product Id**
EPANL 2X4 4800LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4491	37	120	
EPANL 2X4 4800LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4491	37	120	
EPANL 2X4 4800LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4612	37	123	
EPANL 2X4 4800LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4612	37	123	
EPANL 2X4 4800LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4773	37	127	
EPANL 2X4 4800LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4773	37	127	
EPANL 2X4 4800LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Not Listed	4882	37	130	
EPANL 2X4 4800LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	4882	37	130	
EPANL 2X4 5000LMHE 80CRI 40K MIN10 ZT MVOLT NACV	Standard	5218	37	141	PL4KIXE5
EPANL 2X4 5400LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5345	49	109	PJAPOIUK
EPANL 2X4 5400LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5345	49	109	
EPANL 2X4 5400LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5546	49	113	PVKKX9GJ
EPANL 2X4 5400LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5546	49	113	
EPANL 2X4 5400LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5679	49	116	P31GEZNP
EPANL 2X4 5400LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5679	49	116	
EPANL 2X4 5400LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5730	49	117	PWRHGEH4
EPANL 2X4 5400LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5730	49	117	
EPANL 2X4 5400LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5302	41	131	P3J0AC0V
EPANL 2X4 5400LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	5302	41	128	PNWXLXM3
EPANL 2X4 5400LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5302	41	131	
EPANL 2X4 5400LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5421	41	134	P4E4JYPW
EPANL 2X4 5400LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	5421	41	131	PPKAFL54
EPANL 2X4 5400LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5421	41	134	
EPANL 2X4 5400LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5645	41	139	PWC0NHMW
EPANL 2X4 5400LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	5645	41	137	PZRLJ13L
EPANL 2X4 5400LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5645	41	139	
EPANL 2X4 5400LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5825	41	144	PDKG7XHY
EPANL 2X4 5400LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	5825	41	141	P367S8NK
EPANL 2X4 5400LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5825	41	144	
EPANL 2X4 5757LMHE 80CRI 40K MIN10 ZT MVOLT NACV	Standard	5776	40	143	P71Q69QD
EPANL 2X4 6000LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6318	50	126	PCMK605N
EPANL 2X4 6000LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6318	50	126	
EPANL 2X4 6000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6364	50	127	PMHI2SAT
EPANL 2X4 6000LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	6364	55	115	PD2QM1LA
EPANL 2X4 6000LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6364	50	127	
EPANL 2X4 6000LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6548	50	131	P4H3UGFQ
EPANL 2X4 6000LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6548	50	132	
EPANL 2X4 6000LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6622	50	132	P167DCJS
EPANL 2X4 6000LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6622	50	132	
EPANL 2X4 6000LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5755	43	135	P6JUAFCI
EPANL 2X4 6000LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	5755	45	128	PDDV7MOA
EPANL 2X4 6000LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5755	43	135	
EPANL 2X4 6000LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	5884	43	138	PENZU10S
EPANL 2X4 6000LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	5884	45	131	PIVHYPPI
EPANL 2X4 6000LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	5884	43	138	
EPANL 2X4 6000LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6127	43	144	P2GV0F0B
EPANL 2X4 6000LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	6127	45	136	PBOA5LE2
EPANL 2X4 6000LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6127	43	144	
EPANL 2X4 6000LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6322	43	148	PZZYBV55
EPANL 2X4 6000LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	6322	45	140	P888TM5U
EPANL 2X4 6000LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6322	43	148	
EPANL 2X4 6800LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7013	62	113	PSV3OWTM
EPANL 2X4 6800LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7013	62	113	
EPANL 2X4 6800LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7064	62	114	PWGICRXA
EPANL 2X4 6800LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7064	62	114	
EPANL 2X4 6800LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7269	62	117	PPU6PYNE
EPANL 2X4 6800LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	7269	62	111	PTRH2WMJ
EPANL 2X4 6800LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7269	62	117	
EPANL 2X4 6800LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7351	62	118	PHDE0RE3
EPANL 2X4 6800LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7351	62	118	
EPANL 2X4 6800LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6450	48	135	PTT9MBX1
EPANL 2X4 6800LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6450	48	135	
EPANL 2X4 6800LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6596	48	138	PICAPAMD
EPANL 2X4 6800LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6596	48	138	
EPANL 2X4 6800LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6868	48	144	P8IULOJ1
EPANL 2X4 6800LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6868	48	144	

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EPANL LED Flat Panel

Performance Data					
Model No.	**DLC Classification**	**Lumens**	**Watts**	**LPW**	**DLC Product Id**
EPANL 2X4 6800LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7086	48	149	PUZSXKJQ
EPANL 2X4 6800LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7086	48	149	
EPANL 2X4 7200LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7388	66	113	PWVK6LER
EPANL 2X4 7200LM 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	7388	70	106	
EPANL 2X4 7200LM 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7388	66	111	
EPANL 2X4 7200LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7442	66	112	P57KW7H4
EPANL 2X4 7200LM 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Not Listed	7442	70	107	
EPANL 2X4 7200LM 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7442	66	112	
EPANL 2X4 7200LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7657	66	115	P2GQ1ISA
EPANL 2X4 7200LM 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	7657	70	110	PNWQLGKR
EPANL 2X4 7200LM 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7657	66	115	
EPANL 2X4 7200LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7744	66	117	PQMRLFRM
EPANL 2X4 7200LM 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] 347 [ALL OPTIONS]	Standard	7744	70	111	PIIH4OFQ
EPANL 2X4 7200LM 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7744	66	117	
EPANL 2X4 7200LMHE 80CRI 30K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6792	50	137	PJNOUK7J
EPANL 2X4 7200LMHE 80CRI 30K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6792	50	137	
EPANL 2X4 7200LMHE 80CRI 35K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	6945	50	140	PHWEYL0D
EPANL 2X4 7200LMHE 80CRI 35K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	6945	50	140	
EPANL 2X4 7200LMHE 80CRI 40K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7232	50	146	PW3RZAG0
EPANL 2X4 7200LMHE 80CRI 40K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7232	50	146	
EPANL 2X4 7200LMHE 80CRI 50K [MIN1, MIN10] [BLANK, ZT, EZT, NLIGHT] [MVOLT, 120, 277] [ALL OPTIONS]	Standard	7462	50	151	PPYDM8D6
EPANL 2X4 7200LMHE 80CRI 50K [MVOLT, 120, 277] SLD [ALL OPTIONS]	Not Listed	7462	50	151	

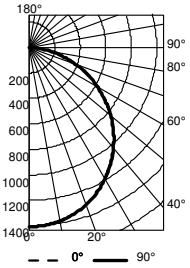
EPANL LED Flat Panel

L10

PHOTOMETRICS

Full Photometric data is available on Lithonia.acuitybrands.com

EPANL 2x2 4000LM 80CRI 40K, 4121 delivered lumens.



CP Summary

	0°	90
0°	1405	1405
5°	1401	1400
15°	1353	1352
25°	1258	1254
35°	1114	1113
45°	940	934
55°	733	727
65°	512	506
75°	280	275
85°	75	73
90	1	1

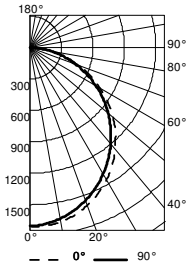
Coefficients of Utilization

	pf				20%								
	pc	80%			70%			50%					
	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%			
RCR	0	119	119	119	116	116	116	111	111	111			
	1	108	103	99	101	97	94	97	94	91			
	2	98	90	83	88	82	76	84	79	74			
	3	90	79	70	77	69	63	74	68	62			
	4	82	70	61	68	60	54	66	59	53			
	5	75	62	53	61	52	46	59	51	46			
	6	69	56	47	55	46	40	53	45	40			
	7	64	51	42	50	41	35	48	41	35			
	8	60	46	38	46	37	32	44	37	31			
	9	56	42	34	42	34	28	41	33	28			
	10	52	39	31	39	31	26	38	31	26			

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1099	26.7	26.7
0° - 40°	1802	43.7	43.7
0° - 60°	3200	77.6	77.6
0° - 90°	4120	100.0	100.0
90° - 120°	1	0.0	0.0
90° - 130°	1	0.0	0.0
90° - 150°	1	0.0	0.0
90° - 180°	1	0.0	0.0
0° - 180°	4121	100.0	100.0

EPANL 2x4 4800LM 80CRI 40K, 5119 delivered lumens.



CP Summary

	0°	90
0°	1703	1703
5°	1707	1689
15°	1653	1610
25°	1535	1477
35°	1364	1300
45°	1154	1086
55°	903	851
65°	636	593
75°	354	335
85°	103	103
90	3	13

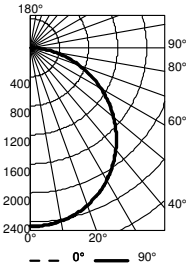
Coefficients of Utilization

	pf				20%								
	pc	80%			70%			50%					
	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%			
RCR	0	119	119	119	116	116	116	111	111	111			
	1	108	103	99	101	97	93	97	94	91			
	2	98	90	83	88	82	76	84	79	74			
	3	90	79	70	77	69	63	74	68	62			
	4	82	70	61	68	60	54	66	59	53			
	5	75	62	53	61	52	46	59	51	46			
	6	69	56	47	55	46	40	53	46	40			
	7	64	51	42	50	41	35	48	41	35			
	8	60	46	38	46	37	32	44	37	31			
	9	56	42	34	42	34	28	41	33	28			
	10	52	39	31	39	31	26	38	31	26			

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1330	26.7	26.7
0° - 40°	2179	43.8	43.8
0° - 60°	3862	77.6	77.6
0° - 90°	4975	100.0	100.0
90° - 120°	1	0.0	0.0
90° - 130°	1	0.0	0.0
90° - 150°	1	0.0	0.0
90° - 180°	1	0.0	0.0
0° - 180°	4976	100.0	100.0

EPANL 2x4 6800LM 80CRI 40K, 7269 delivered lumens.



CP Summary

	0°	90
0°	2461	2461
5°	2461	2451
15°	2387	2376
25°	2221	2218
35°	1977	1975
45°	1674	1671
55°	1311	1317
65°	911	921
75°	508	521
85°	136	158
90	1	15

Coefficients of Utilization

	pf				20%								
	pc	80%			70%			50%					
	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%			
RCR	0	119	119	119	116	116	116	111	111	111			
	1	108	103	99	101	97	93	97	94	90			
	2	98	90	83	88	81	76	84	79	74			
	3	89	79	70	77	69	63	74	67	62			
	4	82	70	61	68	60	53	66	58	53			
	5	75	62	53	61	52	46	59	51	45			
	6	69	56	47	55	46	40	53	45	40			
	7	64	51	42	50	41	35	48	41	35			
	8	60	46	37	45	37	31	44	37	31			
	9	56	42	34	42	34	28	41	33	28			
	10	52	39	31	38	31	26	37	30	26			

Zonal Lumen Summary

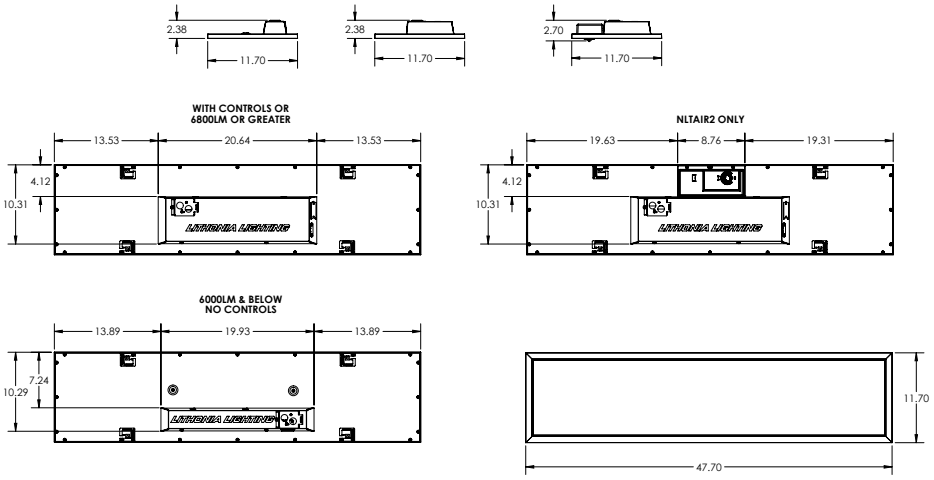
Zone	Lumens	% Lamp	% Fixture
0° - 30°	1927	26.5	26.5
0° - 40°	3164	43.5	43.5
0° - 60°	5632	77.5	77.5
0° - 90°	7271	100.0	100.0
90° - 180°	0	0.0	0.0
0° - 180°	7271	100.0	100.0

EPANL LED Flat Panel

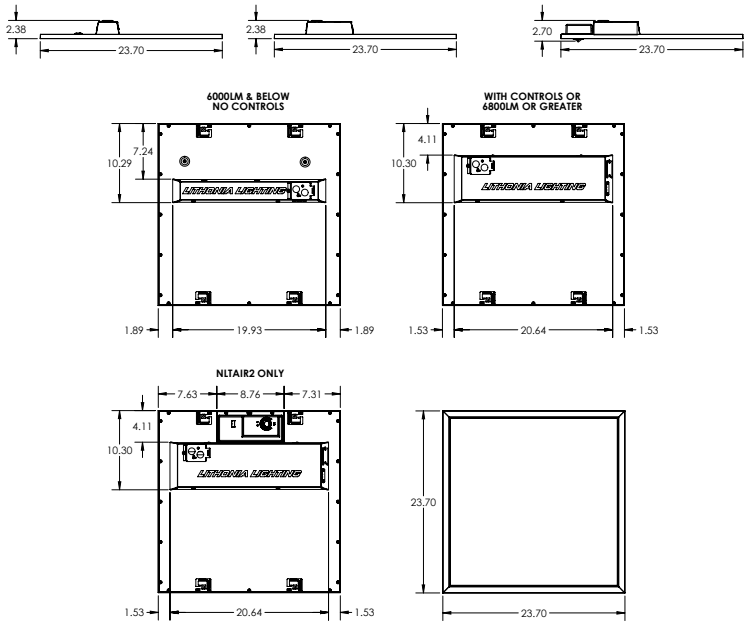
L10

DIMENSIONS

1X4 Configurations



2X2 Configurations

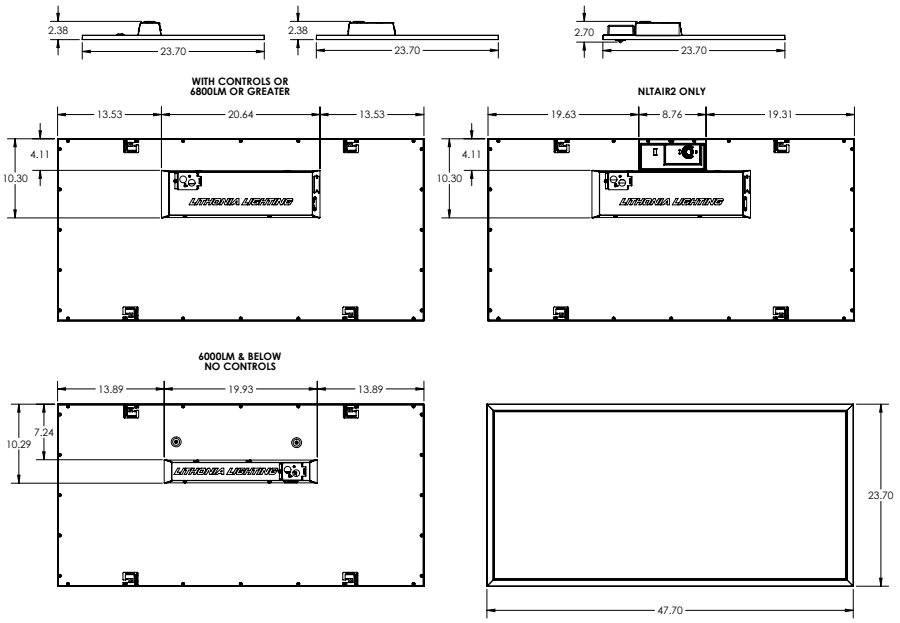


L10

EPANL LED Flat Panel

DIMENSIONS (continued)

2X4 Configurations



COMMERCIAL INDOOR: One Lithonia Way Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.acuitybrands.com

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MEDMASTER SOFTSTEP CONTOUR™ STEPLIGHTS

Semi-Recessed Steplight

MCSL SERIES – DIECAST

PROJECT INFORMATION

Job Name _____

Fixture Type _____

Catalog Number _____

Approved by _____

PRODUCT FEATURES:

- » Semi-recessed wall mount
- » Oval or Rectangle available in horizontal or vertical orientation
- » ADA compliant
- » Amber, White or Blue LED lamp options
- » Lumen output adjustable to 100%, 50% and 25% levels


VO


HO


VR


HR

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURERS.

SPECIFICATIONS

HOUSING: Die-cast aluminum. TGIC polyester powder coat finish – 5-stage pre-treatment. Salt spray test: 1,000 hours. Antimicrobial finish on all exposed components of installed luminaire. See Ordering Information for finish options.

REFLECTOR: Die cast aluminum reflector with integral heat sink.

LENS: UV-stabilized, high-impact resistant injection molded pearlescent polycarbonate.

MOUNTING PLATE: Die formed corrosion resistant steel.

ELECTRICAL: 120-277VAC, 50/60 Hz Maximum input power 3.8 watts. LED light source available in warm white (ANSI 2700K), neutral white (ANSI 4000K), amber (600nm), or blue (470nm). Lumen output adjustable to 100%, 50%, and 25% at time of maintenance or installation. Factory pre-set at 50% dimming level (1.5 watts).

PHOTO CONTROL OPTION: Control circuit shall switch on LED light source when ambient light levels fall below 5fc ± 2.5fc and switch off when light levels are above 15fc ±5fc. Performance may vary depending on location of ambient light sources/windows, room finishes, surrounding objects and fixture lumen output setting.

INSTALLATION: Standard installation requires the back plate to be mounted to a NEMA single-gang junction box (supplied by others). See junction box accessories on page 3 for adjustable thru-wall and single-sided applications. See SoftStep Contour Junction Box Accessories Tech Sheet for application details. Recommended mounting height is 14" from floor to center of luminaire.

PHOTOMETRICS: Photometry tested to the IESNA LM-79-08 standard by an ILAC/ISO17025 accredited laboratory. For additional photometric data, please go to www.kenall.com.

WARRANTY: Limited five (5) year LED warranty.

LISTINGS: UL and CUL Listed for Wet Location. NSF2 Splash/Non-Food Zone. ADA Compliant. Optional UL certified IP64 per IEC 60598.

LED NSF ADA c UL us IP64 OPTION

ORDERING INFORMATION (Ex:MCSL-VO-MW-2L35K-DV)

Model	Style	Finish	Lamp Type	Voltage	Options	Accessories
MCSL				**DV**		

Style
- **VO** Vertical Oval
- **HO** Horizontal Oval
- **VR** Vertical Rectangle
- **HR** Horizontal Rectangle

Finish
- **MW** Matte White (Antimicrobial finish)
- **MB** Matte Black (Antimicrobial finish)
- **BE** Beige
- **BR** Bronze
- **CS** Cool Satin Painted Anodized
- **WS** Warm Satin Painted Anodized
- **CC** Custom Color (Consult Factory)

Lamp Type
- **2L27K** 2 Watt 2700K White LED
- **2L30K** 2 Watt 3000K White LED
- **2L35K** 2 Watt 3500K White LED
- **2L40K** 2 Watt 4000K White LED
- **2LAMB** 2 Watt Amber LED
- **2LBLU** 2 Watt Blue LED

Voltage
- **DV** 120-277 Volts

Options
- **BPC**† Photo Control
- **IP64*** IP64 Certified to IEC 60598
- **SW•**† Rocker Switch

Accessories
- **DBX** Adjustable Thru-Wall Two-Sided Junction Box with Hangers (Requires two steplights per thru-wall junction box.)
- **LPBX** Single-sided Low Profile Single Gang Junction Box with Hangers
- **SBX** Single-Sided Standard Depth Single Gang Junction Box with Hanger

* Must be selected for outdoor use.
• Not available with NSF2 listing. Dry location only.
† Rocker Switch and Photo Control can not be ordered together

www.kenall.com | P: 800-4-Kenall | F: 262-891-9701 | 10200 55th Street Kenosha, Wisconsin 53144, USA

A brand of legrand

For additional photometry, go to www.kenall.com

MEDMASTER SOFTSTEP CONTOUR™ STEPLIGHTS

Semi-Recessed Steplight

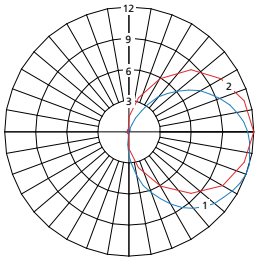
MCSL SERIES – DIECAST

PERFORMANCE

Output	Lamp Type	Initial Delivered Lumens @ 25°C (lm)	Efficacy (lm/W)	Input Power (W)	Drive Current (mA)	Estd. L_{70} LED Life (hrs)
100%	2L35K	38	12	3.3	300	100,000
50%	2L35K	17	13	1.3	150	125,000
25%	2L35K	5	10	0.5	75	150,000

Displayed information above is for the horizontal oval (MCSL-HO) luminaires only. Info subkect to change.
Visit www.kenall.com for IES files and additional information.

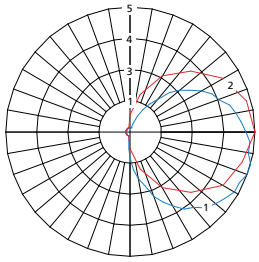
Model: MCSL-HO-MW-2LXXK 100%



Max Candela = 12 Located At Horizontal Angle = 0, Vertical Angle = 70

1 - Vertical Plane Through Horizontal Angles (0 - 180) (Through Max. Cd.)
2 - Horizontal Cone Through Vertical Angle (70) (Through Max. Cd.)

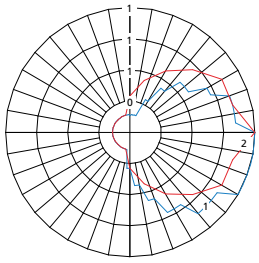
Model: MCSL-HO-MW-2LXXK 50%



Max Candela = 5 Located At Horizontal Angle = 0, Vertical Angle = 70

1 - Vertical Plane Through Horizontal Angles (0- 180) (Through Max. Cd.)
2 - Horizontal Cone Through Vertical Angle (70) (Through Max. Cd.)

Model: MCSL-HO-MW-2LXXK 25%



Max Candela = 1 Located At Horizontal Angle = 0, Vertical Angle = 60

1 - Vertical Plane Through Horizontal Angles (0 - 180) (Through Max. Cd.)
2 - Horizontal Cone Through Vertical Angle (60) (Through Max. Cd.)

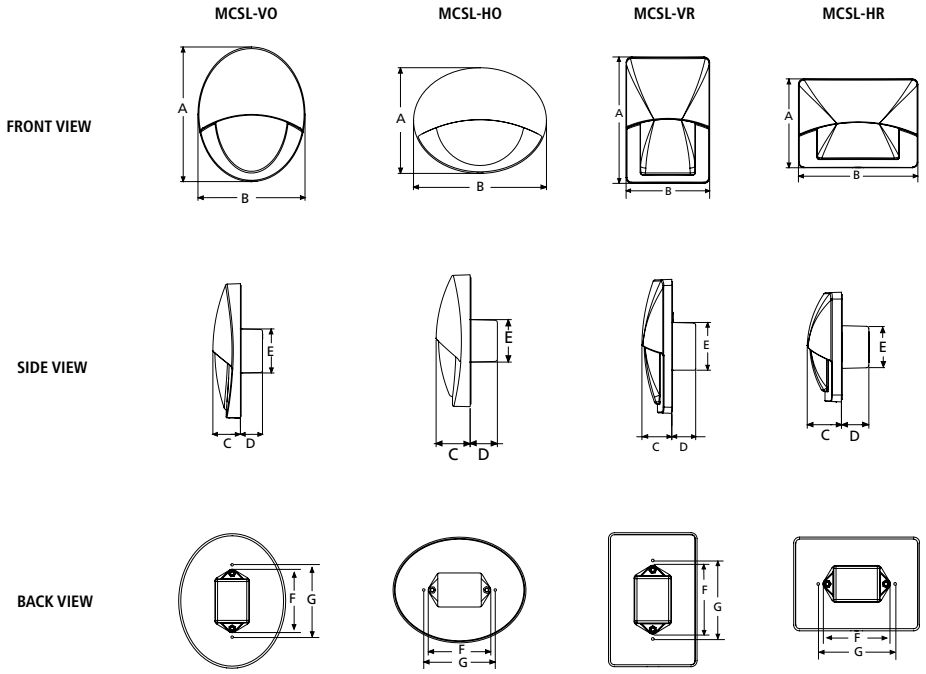
For additional photometry, go to www.kenall.com

MEDMASTER SOFTSTEP CONTOUR™ STEPLIGHTS

Semi-Recessed Steplight

MCSL SERIES – DIECAST

DIMENSIONAL DATA



DIMENSIONAL DATA (IN INCHES)

	A	B	C	D	E	F	G	H	I
VO	6.10	4.85	1.25	1.00	2.00	2.87	3.28	2.37	4.25
HO	4.85	6.10	1.25	1.00	1.56	2.87	3.28	4.25	2.37
VR	5.60	3.70	1.25	1.00	2.00	2.87	3.28	2.37	4.25
HR	4.00	5.38	1.25	1.00	1.56	2.87	3.28	4.25	2.37

RECOMMENDED WALL CUT-OUT

	HEIGHT×WIDTH
VO	4.25×2.37
HO	2.37×4.25
VR	4.25×2.37
HR	2.37×4.25

LITHONIA LIGHTING®

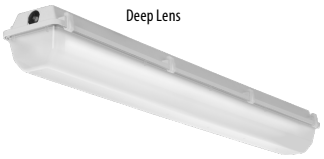
Catalog Number	L12 - HOSE TOWER WALL MT
Notes	PROVIDE SPECIFIED FIXTURE, METALUX 22RDL ORACLE 22-QD-LED, OR ENGINEER APPROVED EQUAL.
Type	

Low-Profile Enclosed and Gasketed Industrial

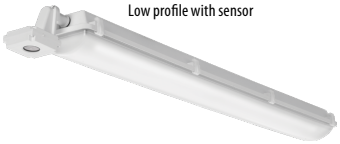
FEM LED

SURFACE/ SUSPENDED/WALL MOUNT

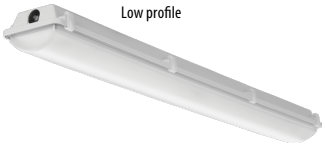
Deep Lens



Low profile with sensor



Low profile



FEATURES & SPECIFICATIONS

INTENDED USE — A general purpose and energy-efficient surface-mounted or suspended LED fixture, suitable for wet, damp and/or cold locations. For vapor-tight demanding environments where moisture or dust is a concern and where relatively low fixture mounting heights and wide fixture spacing are common. Not for use or installation in direct outdoor sunlight. Must be installed under canopy or covered ceiling. For direct sunlight installations, please refer to the FEX product family. Typical applications include industrial facilities, parking garages, retail malls, multi-purpose rooms, garden centers, and food processing. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable use.**

Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.

CONSTRUCTION — One-piece 5VA fiberglass housing with integral perimeter channel utilizing continuous poured-in-place NEMA 4X gasket. Approved for through wiring. Captive polymeric latches are standard. Stainless steel latches (#316) available as an option for food processing or more demanding applications.

Power connection is easily accomplished through pre-drilled holes.

OPTICS — Injection molded, acrylic lens (.080" thick) provides high impact-resistance comparable to 100% DR. A UV stabilized polycarbonate diffuser is available (.080" thick) in clear or frosted for additional impact strength where vandal protection is desired.

Expected service life of 60,000 hours at 80% lumen maintenance (L80); predicted life of more than 100,000 hours.

ELECTRICAL — Utilizes high-efficiency LEDs mounted to core circuit boards. High-efficiency drivers operate 120-277 (MVOLT) and 347-480 (HVOLT) offered with 0-10 volt dimming, dims to 10%. Standard Luminaire Surge Protection Level: 6kV/3kA Surge Rated per ANSI C82.77-5-2015.

INSTALLATION — A pair of stainless steel surface mount brackets (SMB) are included (unless another mounting option is chosen) allowing for surface (ceiling) or suspension mount applications using included bail with aircraft cable or chain. Optional pair of dual pendant mount brackets (DPMB) are available for surface (ceiling) or suspension mount applications using either 3/8" threaded rod or included bail with aircraft cable or chain. Optional pair of angle mounting brackets (ANGBKT) for wall mount applications.

LISTINGS — CSA Certified to UL and C-UL Standards. Suitable for wet location. IP65,IP66, IP67 rated. NSF Splash Zone 2 and Non-Food Zone rated. NEMA 4X rated. Sensors maintain IP65 and IP66 only. See chart on page 5 for Ambient Temperatures.

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.

BUY AMERICAN ACT — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations.
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:

Standard Part Number	Stock Part Number
FEM L48 4000LM LPAFL MD MVOLT GZ10 40K 80CRI	**FEM L48 4L MVOLT**
FEM L48 4000LM LPAFL MD MVOLT GZ10 50K 80CRI	**FEM L48 4L MVOLT 5K**

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 marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

FEM LED Low-Profile Enclosed and Gasketed

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: FEM L48 4000LM IMAFL WD MVOLT GZ10 40K 80CRI

Series	Length	Nominal Lumens	Diffuser	Distribution	Voltage	Driver	Color temperature	CRI
FEM	L24 24" ‡	2000LM 2,000 lumens	IMAFL Acrylic, lineal ribbed frosted lens	MD Medium	MVOLT 120-277V	GZ10 0 - 10V dimming	30K 3000K	80CRI 80 CRI
		3000LM 3,000 lumens	IMACD Acrylic, clear deep lens	WD Wide	HVOLT 347-480V ‡		35K 3500K	90CRI 90 CRI
		4000LM 4,000 lumens	IMAFD Acrylic, deep frosted lens	PGD Parking garage	120 120V		40K 4000K	
		6000LM 6,000 lumens	LPAFL Acrylic, low profile frosted lens		277 277V		50K 5000K	
	L48 48" ‡	3000LM 3,000 lumens	LPACL Acrylic, low profile clear lens		347 347V			
		4000LM 4,000 lumens	LPPCL Polycarbonate, low profile clear lens		480 480V			
		6000LM 6,000 lumens	LPPFL Polycarbonate, low profile frosted lens					
		8000LM 8,000 lumens						
		10000LM 10,000 lumens						
		12000LM 12,000 lumens						
	L96 96" ‡	9000LM 9,000 lumens						
		12000LM 12,000 lumens						
		15000LM 15,000 lumens						
		18000LM 18,000 lumens						
		20000LM 20,000 lumens						
		24000LM 24,000 lumens						

PROVIDE FOR FIXTURE WHERE INDICATED AS EMERGENCY

Options

Emergency:

E10WMCP	EM Self-diagnostics battery pack, MVOLT, 10W, Constant Power Certified in the California Title 20 Modernized Appliance Efficiency Database (MAEDBS) ‡
BE6WCP	Cold Weather EM battery pack, 120/277V, 6W, Constant Power Certified in the California Title 20 Modernized Appliance Efficiency Database (MAEDBS) ‡
BGTD	Generator transfer device

Other Options:

ANGBKT	Angle bracket shipped with fixture ‡
BAA	Buy America(n) Act Compliant
DPMB	Dual pendant mounting bracket ‡
SPD	Surge protection device, additional 10kV/6kA
STSL	Stainless steel latches
TRS	Tamper Resistant Torx® T10 screws
WLF	Wet location fitting (two outboard, top (L24 - 20 inches off-center, L48 - 48 inches off-center, L96 - 95.7 inches off-center) ‡
WLFEND	Wet location fitting (one end) ‡
WLFEND2	Wet location fitting (both ends) ‡
WLFPMP	Wet location pendant monopoint ‡

Cord Sets: ‡

CPSB16YWLBH	Brad Harrsion Mini-Change® cordset with straight blade plug, 16 gauge, 3 conductors, 6ft, yellow ‡
CPSB16YWL12FTBH	Brad Harrsion Mini-Change® cordset with straight blade plug, 16 gauge, 3 conductors, 12ft, yellow ‡
CRSB16YWLBH	Brad Harrison Mini-Change® receptacle ‡
CNP16WWL	Cord only (no plug), 16 gauge, 3 conductors, white, 6ft, wet location ‡
CNP16WWL12FT	Cord only (no plug), 16 gauge, 3 conductors, white, 6ft, wet location ‡
CNP164CWWL	Cord only (no plug), 16 gauge, 4 conductors, white, 6ft, wet location (for use when unswitched circuit is required for battery pack) ‡

Individual Controls: ‡

SBOR10	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, ON/OFF occupancy (LINK) (formerly MSI10NWL)
SBOR10 HL 3V	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, occupancy controlled dimming (bi-level) (LINK) (formerly MSI102L3VWL)
SBOR10 P	360° Low mount sensor, (8-15' mounting heights), outdoor PIR, ON/OFF photocell (LINK) (formerly MSI10NWL DSCNWL)

nLight Wireless: ‡

NLTAIR2 RSBOR10	nLight® Air Generation 2 enabled, 360° low mount sensor, (8-15' heights) (LINK)
NLTAIR2 RIO	nLight® Air Generation 2 enabled, fixture embedded network interface, 0-10V dimming output (LINK)

NOTE: ‡ indicates option chosen has ordering restrictions. Please reference ordering restrictions chart, page 3. Options are sorted alphanumerically.

ELECTRICAL CONTRACTOR TO DETERMINE MOUNTING OPTIONS AND ACCESSORIES

Accessories: *Order as separate catalog number.*

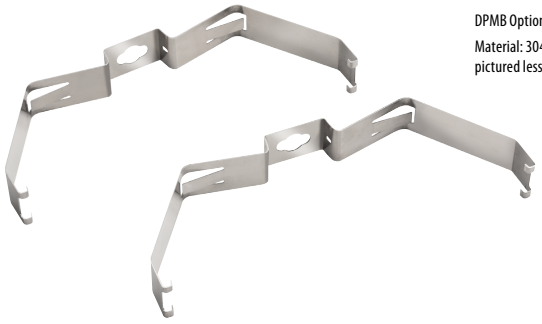
MHCH 36	3 foot (36 inches) jack chain (pair)
MHHK120	10 foot (120 inches) single leg air craft cable (ships as pair)
MHHK120SS	10 foot (120 inches) single leg air craft cable, stainless steel (ships as pair)
RK1 T10BIT W/PIN U	Hex-base driver bit, Torx TX10, for tamper resistant screws with center reject pin
FEMDPMB	Dual pendant mounting bracket (ships as a pair) ‡
FEMANGBKT	Angle bracket (ships as pair) ‡
FEMSMB	Surface mount bracket (ships as pair) ‡

See Accessories and ordering restrictions on next page.

FEM LED Low-Profile Enclosed and Gasketed

‡ Option Value Ordering Restrictions	
Option value	**Restriction**
ANGBKT, FEMANGBKT	For wall mount applications. If mounted in an upward orientation, fixture will be damp location listed only.
BE6WCP	Utilizes Bodine BSL36 Cold-Pak emergency driver. Not available with L24 length. Order with CNP164CWWL when unswitched hot is required for battery. Not available with 347V,480V,HVOLT.
CNP16WWL, CNP16WWL12FT	Not available with BE6WCP or E10WMCP.
CNP164CWWL	Available with BE6WCP or E10WMCP only. **Not NEMA4X rated**.
Cord Sets	**Not NEMA4X rated**.
CPSB16YWLBH, CPSB16YWL12FTBH	Not available with BE6WCP or E10WMCP.
CRSB16YWLBH	Not available with BE6WCP or E10WMCP.
E10WMCP	Utilizes Power Sentry, PS1055MCP battery pack. Order with CNP164CWWL when unswitched hot is required for battery. Not available with 347V,480V,HVOLT.
DPMB, FEMDPMB	For surface (ceiling) or suspension mount applications using either 3/8" threaded rod or included bail with aircraft cable or chain.
FEMSMB	Ships standard with fixture (unless another mounting option is chosen). For surface (ceiling) or suspension mount applications using included bail with aircraft cable or chain.
HVOLT	When ordered with L24, available with 6000LM only. When ordered with L48, not available with 3000LM or 4000LM.
Individual Controls	**Not NEMA4X rated. IP65 and IP66 rated.**
L24	Not available with BE6WCP.
L48	Not available with WLFPMP.
L96	Not available with WLFPMP
nLight® Wireless	**Not NEMA4X rated. IP65 and IP66 rated.**
WLF	If cord is ordered, cord will exit from the end of the fixture. **Not NEMA4X rated**.
WLFEND	If cord is ordered, cord will exit from the end of the fixture. **Not NEMA4X rated**. Available with cord or sensor option. Choose only one.
WLFEND2	Not available with sensor or cord options. **Not NEMA4X rated**.
WLFPMP	Available only with L24. **Not NEMA4X rated.**

MOUNTING OPTIONS



DPMB Option or FEMDPMB Accessory

Material: 304 Stainless Steel
pictured less bail wire

CS88L12/CS88R options

FEM LED Low-Profile Enclosed and Gasketed

OPERATIONAL DATA (80 CRI*, MD**, MVOLT***)

Length	Package	Input Wattage	CCT	Frosted Lens' Lumens (LPW)				Clear Lens' Lumens (LPW)		
				IMAFL	IMAFD	LPAFL	LPPFL	IMACD	LPACL	LPPCL
L24	2000LM	13.4	30K	1962 (147)	2083 (156)	2076 (155)	1861 (139)	2112 (158)	2105 (158)	1890 (142)
			35K	2002 (150)	2126 (159)	2118 (159)	1899 (142)	2155 (161)	2147 (161)	1929 (144)
			40K	2099 (157)	2228 (167)	2220 (166)	1991 (149)	2259 (169)	2251 (169)	2022 (151)
			50K	2122 (159)	2252 (169)	2244 (168)	2013 (151)	2284 (171)	2276 (170)	2044 (153)
	3000LM	19.9	30K	2869 (144)	3046 (153)	3035 (153)	2721 (137)	3088 (155)	3077 (155)	2764 (139)
			35K	2927 (147)	3108 (156)	3096 (156)	2777 (140)	3151 (158)	3139 (158)	2820 (142)
			40K	3069 (154)	3258 (164)	3246 (163)	2911 (146)	3303 (166)	3291 (166)	2956 (149)
			50K	3102 (156)	3293 (166)	3281 (165)	2942 (148)	3339 (168)	3327 (167)	2988 (150)
	4000LM	26.0	30K	3676 (142)	3903 (150)	3889 (150)	3487 (134)	3957 (152)	3943 (152)	3541 (136)
			35K	3751 (145)	3982 (153)	3968 (153)	3558 (137)	4037 (156)	4023 (155)	3613 (139)
			40K	3932 (152)	4174 (161)	4159 (160)	3730 (144)	4232 (163)	4217 (162)	3788 (146)
			50K	3975 (153)	4219 (163)	4204 (162)	3770 (145)	4278 (165)	4263 (164)	3829 (148)
	6000LM	39.2	30K	5287 (135)	5613 (143)	5593 (143)	5015 (128)	5691 (145)	5671 (145)	5093 (130)
			35K	5395 (138)	5727 (146)	5707 (145)	5117 (130)	5806 (148)	5786 (147)	5196 (132)
			40K	5655 (144)	6004 (153)	5982 (153)	5364 (137)	6087 (155)	6065 (155)	5447 (139)
			50K	5717 (146)	6069 (155)	6047 (154)	5422 (138)	6153 (157)	6131 (156)	5506 (140)
L48	3000LM	18.0	30K	2689 (149)	2855 (158)	2844 (158)	2551 (141)	2894 (160)	2884 (160)	2590 (144)
			35K	2743 (152)	2912 (161)	2902 (161)	2602 (144)	2953 (164)	2942 (163)	2643 (146)
			40K	2876 (159)	3053 (169)	3042 (169)	2728 (151)	3095 (172)	3084 (171)	2770 (154)
			50K	2907 (161)	3086 (171)	3075 (170)	2758 (153)	3129 (173)	3118 (173)	2800 (155)
	4000LM	23.8	30K	3543 (149)	3762 (158)	3748 (157)	3361 (141)	3814 (160)	3800 (160)	3413 (143)
			35K	3615 (152)	3838 (161)	3824 (161)	3429 (144)	3891 (163)	3877 (163)	3482 (146)
			40K	3790 (159)	4023 (169)	4009 (168)	3595 (151)	4079 (171)	4064 (171)	3650 (153)
			50K	3831 (161)	4067 (171)	4052 (170)	3634 (153)	4123 (173)	4109 (173)	3690 (155)
	6000LM	37.8	30K	5284 (140)	5609 (149)	5589 (148)	5012 (133)	5687 (151)	5667 (150)	5090 (135)
			35K	5391 (143)	5723 (152)	5703 (151)	5114 (135)	5802 (154)	5782 (153)	5193 (138)
			40K	5651 (150)	6000 (159)	5978 (158)	5361 (142)	6083 (161)	6061 (161)	5444 (144)
			50K	5713 (151)	6065 (161)	6043 (160)	5419 (144)	6149 (163)	6127 (162)	5503 (146)
	8000LM	50.5	30K	6952 (138)	7380 (146)	7354 (146)	6594 (131)	7482 (148)	7456 (148)	6696 (133)
			35K	7093 (141)	7530 (149)	7503 (149)	6728 (133)	7634 (151)	7607 (151)	6832 (135)
			40K	7435 (147)	7894 (156)	7865 (156)	7053 (140)	8003 (159)	7975 (158)	7162 (142)
			50K	7516 (149)	7979 (158)	7950 (158)	7129 (141)	8090 (160)	8061 (160)	7240 (144)
	10000LM	62.0	30K	8646 (140)	9179 (148)	9146 (148)	8201 (132)	9306 (150)	9273 (150)	8328 (134)
			35K	8822 (142)	9365 (151)	9332 (151)	8368 (135)	9495 (153)	9461 (153)	8497 (137)
			40K	9248 (149)	9817 (158)	9782 (158)	8772 (142)	9953 (161)	9918 (160)	8908 (144)
			50K	9348 (151)	9924 (160)	9888 (160)	8867 (143)	10061 (162)	10026 (162)	9004 (145)
	12000LM	75.0	30K	10406 (139)	11047 (147)	11007 (147)	9871 (132)	11200 (149)	11160 (149)	10024 (134)
			35K	10617 (141)	11271 (150)	11231 (150)	10071 (134)	11427 (152)	11387 (152)	10227 (136)
			40K	11130 (148)	11816 (157)	11773 (157)	10557 (141)	11979 (160)	11937 (159)	10721 (143)
			50K	11251 (150)	11944 (159)	11901 (159)	10672 (142)	12109 (161)	12066 (161)	10837 (144)
L96	9000LM	53.4	30K	7962 (149)	8452 (158)	8422 (158)	7552 (141)	8570 (160)	8539 (160)	7669 (144)
			35K	8124 (152)	8624 (161)	8593 (161)	7706 (144)	8743 (164)	8713 (163)	7825 (146)
			40K	8516 (159)	9040 (169)	9008 (169)	8078 (151)	9166 (172)	9133 (171)	8203 (154)
			50K	8608 (161)	9138 (171)	9106 (170)	8165 (153)	9265 (173)	9232 (173)	8292 (155)
	12000LM	75.5	30K	10570 (140)	11221 (149)	11181 (148)	10026 (133)	11377 (151)	11337 (150)	10182 (135)
			35K	10785 (143)	11449 (152)	11408 (151)	10230 (135)	11608 (154)	11567 (153)	10388 (138)
			40K	11306 (150)	12002 (159)	11959 (158)	10724 (142)	12168 (161)	12125 (161)	10890 (144)
			50K	11428 (151)	12132 (161)	12089 (160)	10840 (144)	12300 (163)	12257 (162)	11008 (146)
	15000LM	94.3	30K	13399 (142)	14225 (151)	14174 (150)	12710 (135)	14422 (153)	14371 (152)	12907 (137)
			35K	13671 (145)	14513 (154)	14461 (153)	12968 (138)	14714 (156)	14662 (156)	13169 (140)
			40K	14331 (152)	15214 (161)	15160 (161)	13594 (144)	15425 (164)	15370 (163)	13805 (146)
			50K	14487 (154)	15379 (163)	15324 (163)	13741 (146)	15592 (165)	15537 (165)	13954 (148)
	18000LM	103.4	30K	15901 (154)	16881 (163)	16820 (163)	15083 (146)	17114 (165)	17054 (165)	15317 (148)
			35K	16224 (157)	17223 (167)	17161 (166)	15389 (149)	17462 (169)	17400 (168)	15627 (151)
			40K	17007 (164)	18055 (175)	17990 (174)	16132 (156)	18305 (177)	18240 (176)	16382 (158)
			50K	17192 (166)	18251 (176)	18185 (176)	16307 (158)	18503 (179)	18438 (178)	16560 (160)
	20000LM	125.5	30K	17549 (140)	18630 (148)	18564 (148)	16646 (133)	18888 (150)	18822 (150)	16904 (135)
			35K	17906 (143)	19008 (151)	18940 (151)	16984 (135)	19272 (154)	19204 (153)	17247 (137)
			40K	18770 (150)	19927 (159)	19855 (158)	17804 (142)	20202 (161)	20131 (160)	18080 (144)
			50K	18974 (151)	20143 (160)	20070 (160)	17997 (143)	20421 (163)	20349 (162)	18276 (146)
	24000LM	149.5	30K	21142 (141)	22445 (150)	22364 (150)	20055 (134)	22756 (152)	22675 (152)	20365 (136)
			35K	21571 (144)	22900 (153)	22818 (153)	20461 (137)	23217 (155)	23135 (155)	20779 (139)
			40K	22613 (151)	24006 (161)	23920 (160)	21450 (143)	24339 (163)	24253 (162)	21782 (146)
			50K	22858 (153)	24266 (162)	24179 (162)	21682 (145)	24602 (165)	24516 (164)	22018 (147)

* For 90CRI, reduce lumen output by 17.1%
** For WD reduce output by 4.7%, PGD reduce output by 5.4%
*** For HVOLT use scale factor in HVOLT SCALE FACTOR TABLE

FEM LED Low-Profile Enclosed and Gasketed

CSA LISTED AMBIENT RATING*

		Standard** (surface)"	Standard** (suspended)"	E10WMCP (surface)	E10WMCP (suspended)	BE6WCP (surface)	BE6WCP (suspended)
L24	2000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	3000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	4000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	6000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
L48	3000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	4000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	6000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	8000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	10000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	12000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
L96	9000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	12000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	15000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	18000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	20000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C
	24000LM	35°C	50°C	5°C - 25°C	5°C - 35°C	-20°C - 25°C	-20°C - 35°C

*Minimum Ambient is -30°C unless noted, when the fixture is suspended at least 12" from the ceiling.
**All options not specifically listed in this table are considered standard

HVOLT SCALE FACTOR

	Factor
2000LM	0.814
3000LM	0.814
4000LM	0.814
6000LM	0.835
8000LM	0.845
9000LM	0.850
10000LM	0.850
12000LM	0.845
15000LM	0.860
18000LM	0.880
20000LM	0.845
24000LM	0.865

CONFIGURATION WEIGHTS

	Standard	w/ Sensor	w/ Battery
L24	8	9	9
L48	11	12	12
L96	23	24	24

NUMBER OF BOARDS AND DRIVERS

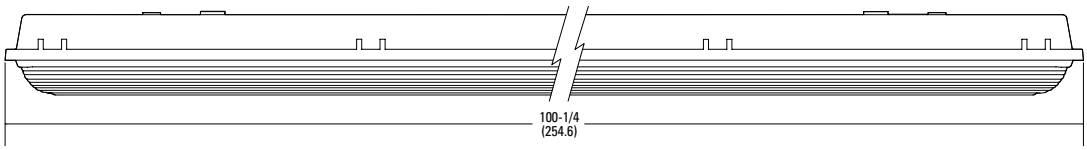
Lumen package	Fixture length	Number of boards	Number of drivers
2000LM	L24	1	1
3000LM		1	1
4000LM		1	1
6000LM		1	1
3000LM	L48	2	1
4000LM		2	1
6000LM		2	1
8000LM		2	1
10000LM		2	1
12000LM		2	1
9000LM	L96	4	1
12000LM		4	2
15000LM		4	2
18000LM		4	2
20000LM		4	2
24000LM		4	2

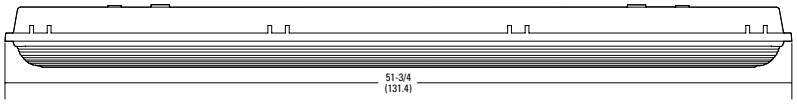
FEM LED Low-Profile Enclosed and Gasketed

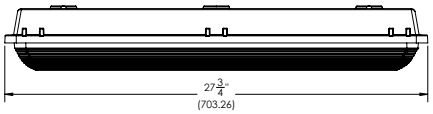
DIMENSIONS

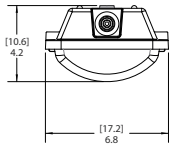
Specifications subject to change without notice.
All dimensions are inches (centimeters) unless otherwise indicated.

Weight (may vary with options or accessories)
FEM L48: 11.9 lbs (5.397kg)
FEM L96: 24.3 lbs (11.022kg)

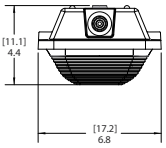




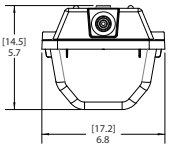




Diffuser Type:
LPAFL
LPACL
LPPFL
LPPCL



Diffuser Type:
IMAFL



Diffuser Type:
IMAFD
IMACD

PHOTOMETRICS

See www.lithonia.com for photometry reports.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L5

Decorative Indoor

Contemporary Square Vanity

VANITY LED

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURERS OR ENGINEER APPROVED EQUAL.

ADA

ENERGY STAR

U.S. PATENT PENDING

FEATURES & SPECIFICATIONS

INTENDED USE

Provides an LED lighting platform to deliver general or task lighting for residential and light commercial applications. Light engine delivers long life and excellent color to ensure a quality, low-maintenance light installation. Ideal for use in bathrooms, lavatories, hallways, corridors, stairways, utility areas and more.

CONSTRUCTION

The Contemporary Square Vanity is constructed of an acrylic diffuser with a brushed nickel housing. The included canopy/junction box cover is removable for a more low-profile look (2' only). The white acrylic diffuser provides even illumination and softens the appearance of the LEDs for improved aesthetics.

OPTICS

2' produces 1300 lumens and 3' produces 1900 lumens at 3000K with 50,000 hours of life.

Extruded acrylic diffuser is of highly transmissive material to minimize LED image and provides high-angle brightness control.

ELECTRICAL

Long-life LEDs, coupled with a multivolt driver, provide extended service life. Standard input = 18 watts, (2'); 26 watts, (3'). Fixture is rated to deliver L70 performance at 50,000 hours and operates at 120-277 volts.

Use with non-dimmable switches only.

LISTINGS

UL Listed to US and Canadian safety standards. Listed for damp locations. ENERGY STAR® certified.

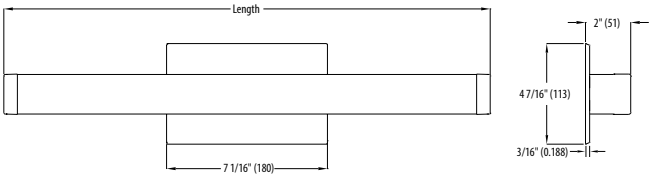
WARRANTY

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.

SPECIFICATIONS	2FT	3FT
Length:	21-7/16 (545)	33-1/4 (845)
Weight:	2.15 (.98)	2.55 (1.16)
3000K Lumens (LPW)	1304 (72)	1922 (73)

All dimensions are inches (millimeters) unless otherwise indicated.
Weights are pounds (kilograms).



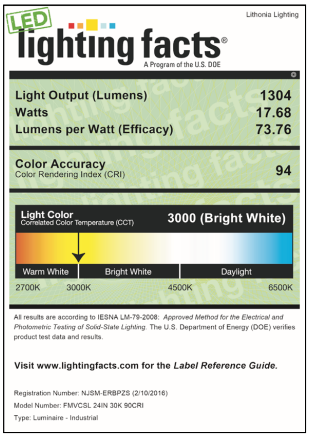
ORDERING INFORMATION

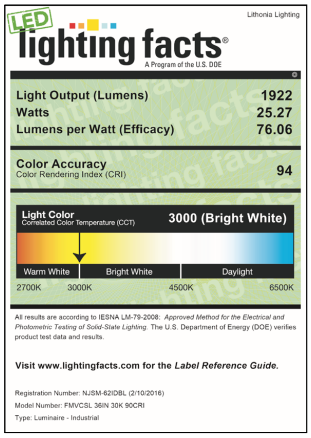
Example: FMVCSL 24IN MVOLT 30K 90CRI BN

Series	Length	Voltage	Color temperature	CRI	Finish
FMVCSL Contemporary Square Vanity	**24IN** 2' Nominal **36IN** 3' Nominal	**MVOLT** MVOLT (120V-277V)	**30K** 3000 K	**90CRI** >90	**BN** Brushed Nickel

LED Vanity Contemporary Square

LIGHTING FACTS





LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	L8A

FEATURES & SPECIFICATIONS

INTENDED USE — Ideal for use in applications where smart, energy-efficient fixtures are desired. Typical applications include parking garages, canopies, transportation, schools, hospitals, cold storage and exterior retail environments where moisture or dust is a concern. Polycarbonate enclosure protects fixture while remaining easy to service and clean. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.**

CONSTRUCTION — UV-stabilized, injection-molded, impact-resistant, frosted polycarbonate housing with continuous poured in place, closed-cell gasket. 20-gauge steel channel and channel cover. Aluminum sheet metal board plate for thermal conduction and support. Captive, tamper-resistant, polycarbonate latches standard (8 Torx T-20 tamper-resistant screws included). Stainless steel latches also available. Fixture design allows for approximately 4% up-light.

OPTICS — UV-stabilized, injection-molded, impact-resistant, clear transparent and frosted, polycarbonate lens with aesthetic rib detail (.080" thick). Miro 5 aluminum reflector used to achieve wide distribution.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Standard 0-10V dimming. Integral 6kV/3kA surge protection, tested in accordance to IEEE/ANSI standards. >L88 at 60,000 hours (see chart on page 3).

INSTALLATION — Stainless steel surface mount brackets standard (2 included) allows for ceiling or suspended mount. A variety of stainless steel mounting options also available: J-box mounting and mounting brackets for suspension with aircraft cable (cable not included). Optional stainless steel V-hooks available for chain hanging (chain not included). Surface conduit entry on each end and on top. For horizontal and vertical mounting on a wall, application must be under a covered ceiling and QMB option recommended. 1/2" - 3/4" KO. When wall mounted the product will be rated for damp location only.

LISTINGS — CSA Certified to UL and C-UL standards. For use in ambient temperatures ranging from -20°F (-29°C) to 104°F(40°C). VAP LED is wet location listed for covered ceiling applications. IP65 and IP66 rated. VAP LED is NSF Splash Zone rated when suspended or ceiling mounted. When wall mounted the product will be rated for damp location only. 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.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

For installed Rough Service Product(s), Acuity warrants that, for the lifetime of the product(s), the polycarbonate lens and/or polycarbonate housing will withstand breakage resulting from occasional physical abuse and rough handling (the "Rough Service Warranty"), not withstanding the vandalism exclusion set forth at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

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.

PROVIDE SPECIFIED FIXTURE LITHONIA LIGHTING VAP LED, LUMAX LIGHTING VWBTLED SERIES, COLUMBIA LIGHTING LXEM, OR ENGINEER APPROVED EQUAL.

ARCHWAY™ PASSAGE™

Rough Service Fixture

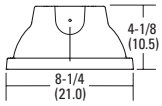
VAP LED

CEILING/
SUSPEND MOUNT

Specifications

Length: 54-3/4 (139.1)
Width: 8-1/4 (21.0)
Depth: 4-1/8 (10.5)
Weight: 13.5 lbs. (5.9 kg)

All dimensions are shown in inches (centimeters) unless otherwise noted.



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® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

L8A

VAP Linear Rough Service, LED

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: VAP 4000LM FST MD MVOLT GZ10 40K 80CRI

VAP							
Series	**Nominal lumens**	**Diffuser**	**Distribution**	**Voltage**	**Driver**	**Color temperature**	**CRI**
VAP	4000LM 4,000 lumens	FST Frosted polycarbonate lens	MD Medium	MVOLT 120/277V	GZ10 0 - 10V dimming	30K 3000K	80CRI 80 CRI
	6000LM 6,000 lumens	PCL Clear polycarbonate lens	WD Wide	120 120V		35K 3500K	90CRI 90 CRI
	8000LM 8,000 lumens[1]			277 277V		40K 4000K	
	12000LM 12,000 lumens[1,2,3]			HVOLT 357/480V		50K 5000K	
	15000LM 15,000 lumens[1,3,4,5]			347 347V			
				480 480V			

PROVIDE EMERGENCY BATTERY PACK WHERE INDICATED AS EMERGENCY FIXTURE ON PLAN

Options

BSL520	Bodine® emergency LED battery pack for -20°C and up, CA Title 20 Noncompliant[4,5,6,7]	STSL	Stainless steel tamper resistant latches	Individual Controls:[7,8,15]	
E15WCP	Emergency battery pack, 15W constant power, Certified in CA Title 20 MAEDBS[4,6,7,8,9]	QMB	Quick-mount ceiling bracket	MSI10NWL	Low mount 360 integral motion sensor, wet location, On/Off operation
WLF	Wet location fitting (two outboard, top)[10]	CMB	Chain-mount suspension bracket	MSI102L3VWL	Low mount 360 integral motion sensor, wet location, High/Low operation (bi-level)
WLFIN	Wet location fitting (two inboard, top)[10]	JSB	Junction box snap-bracket	MSI10NWL DSCNWL	Low mount 360 integral motion sensor, wet location, On/Off operation for motion sensing, override Off due to daylight
WLFEND	Wet location fitting (one end)	LSC	Lens safety clip	Xpoint Wireless:[15]	
WLFEND2	Wet location fitting (both ends)[10,11]	DL	Damp location	XAD	XPoint™ wireless controller ,0-10V dimming[4,7,13]
CS89	6' white cord, 16/3, no plug, wet location[12]	BGTD	Bodine generator transformer device[4,7,8,13]	MSI10XAWL10M DSCXAWL	XPoint™ wireless integral motion sensor, On/Off operation for motion sensing, override Off due to daylight[8]
CS88	6' Brad Harrison 16/3 cord and straight blade plug set[8]	SF	Single fuse (120, 277, 347V)	nLight Air2:	
CS88L12	12' Brad Harrison 16/3 cord and straight blade plug set[8]	DF	Double fuse (208, 240, 480V)	NLTAIR2 RSBOR10	nLight AIR generation 2 enabled 360 low mount motion sensor[7,8,14]
		SPD	Surge protection device[14]		

PROVIDE STEM MOUNTING. LENGTH AS REQUIRED PER BOTTOM OF FIXTURE MOUNTING HEIGHT.

Accessories: *Order as separate catalog number. (Ships separately)*

VAPSMB	Surface-mount bracket	RK1 T20BIT	Hex base driver bit, Torx T20 Tamper resistant screws with center reject pin
VAPQMB	Quick-mount ceiling bracket	RK1 T20DRV	Torx T20 screwdriver for use with tamper resistant screws with center reject pin
VAPCMB	Chain-mount bracket		
VAPJSB	Junction box snap bracket		
HC36	Wire hook and 36" chain set[16,17]		

Notes

1 Not available with BSL520 battery option
2 When used with XAD, HVOLT, 347 and 480, maximum ambient temperature is 35°C.
3 Not available with E15WCP.
4 Not available with HVOLT, 347 and 480.
5 Maximum ambient temperature 35°C.
6 Not available with XPoint options.
7 Not available with SPD as the SPD is standard with option.
8 Must specify voltage.
9 Minimum ambient temperature is 0°C. Title 20 compliant. Maximum mounting height is 25ft.
10 Utilizes 5/8" long NPT threaded hub.
11 Not available with cord, sensor or photocell options.
12 Fixtures ship with black 4-conductor cords when BSL520 options are ordered.
13 If used with 8000LM, 12000LM or 15000LM, maximum ambient temperature is 35°C.
14 For additional protection up to 10kV.
15 Not available with multiple control options - other MSE or Xpoint.
16 Requires CMB (chain mount bracket) option.
17 For stainless steel, specify STS (ex. HC36 STS).

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-7378 www.lithonia.com
 Rev. 04/16/2019

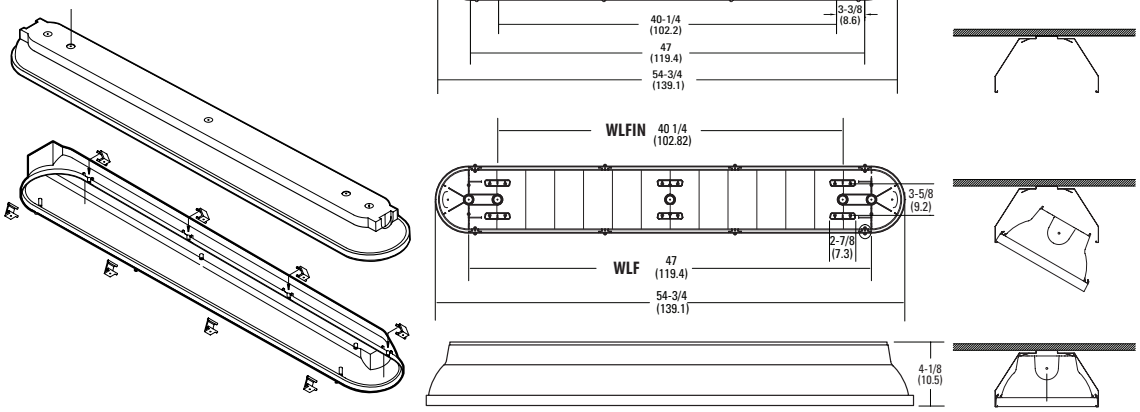
L8A

VAP Linear Rough Service, LED

DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

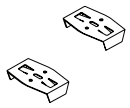
Specifications subject to change without notice.



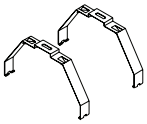
MOUNTING ACCESSORIES

CMB - Chain Mounting Brackets

JSB - Junction Box Mounting Bracket



QMB - Quick-Mount Mounting Brackets



SMB - Surface Mount Brackets (ship with fixture as standard)

ARCHWAY™ PASSAGE™ LED Specification Matrix											
Nominal lumens	Distribution	Initial delivered lumens @ 80CRI with clear polycarbonate lens				Initial delivered lumens @80CRI with frosted polycarbonate lens				Wattage @120V	Comparable source
		30K	35K	40K	50K	30K	35K	40K	50K		
4000LM	MD	4295	4446	4517	4647	3695	3777	3887	3998	33	2-lamp 32W T8, 1-lamp 54W T5, 70W HID
	WD	4208	4357	4426	4553	3623	3750	3810	3919		
6000LM	MD	6013	6226	6325	6506	5174	5357	5443	5598	49	3-lamp 32W T8, 2-lamp 54W T5, 100W HID
	WD	5892	6100	6198	6375	5072	5251	5335	5488		
8000LM	MD	8348	8643	8781	9032	7183	7437	7556	7772	67	4-lamp 32W T8, 2-lamp 54W T5, 150W HID
	WD	8180	8469	8604	8850	7042	7290	7407	7618		
12000LM	MD	11742	12156	12350	12703	10103	10460	10627	10931	99	6-lamp 32W T8, 3-lamp 54W T5, 250W HID
	WD	11505	11911	12101	12447	9904	10254	10417	10715		
15000LM	MD	14519	15031	15271	15708	12493	12934	13140	13516	115	6-lamp 32W T8, 4-lamp 54W T5, 250W HID
	WD	14226	14728	14963	15391	12246	12679	12881	13249		

Lumen Mantenance @ 25C

Operating Hours	0	10,000	20,000	25,000	35,000	50,000	60,000	75,000	100,000
4000LM	1	0.980	0.973	0.969	0.962	0.952	0.95	0.935	0.919
6000LM	1	0.972	0.962	0.957	0.950	0.933	0.923	0.909	0.886
8000LM	1	0.962	0.947	0.94	0.925	0.903	0.889	0.868	0.834
12000LM	1	0.970	0.960	0.952	0.940	0.922	0.910	0.900	0.865
15000LM	1	0.969	0.956	0.949	0.936	0.917	0.905	0.886	0.857

L8A

VAP Linear Rough Service, LED

OPTIONS AND ACCESSORIES

The DMW2 Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

rSBOR/SBOR – Fixture Mount Sensor (see www.sensorswitch.com for additional information)

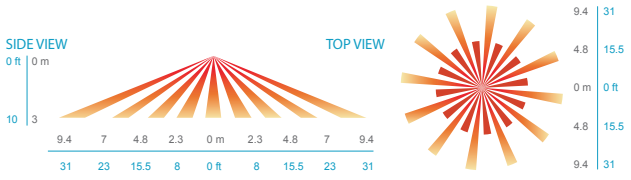
- 360° coverage
- On/Off dim
- Photocell optional
- IP66 rated
- Photocell and 0-10VDC dimming options.

Fixture sensor nomenclature	RSBOR/SBOR sensor nomenclature
For shortest lead times use one of the following SBOR configurations	
NLTAIR2 RSBOR10	RSBOR 10 EB4 WH G2
MSI10NWL	SBOR 10 OEX EB4 WH
MSI102L3VWL	SBOR 10 OEX D EB4 WH 3V
MSI10NWL DSCNWL	SBOR 10 OEX P EB4 WH

COVERAGE PATTERNS

PARKING GARAGE / LOW MOUNT APPLICATIONS

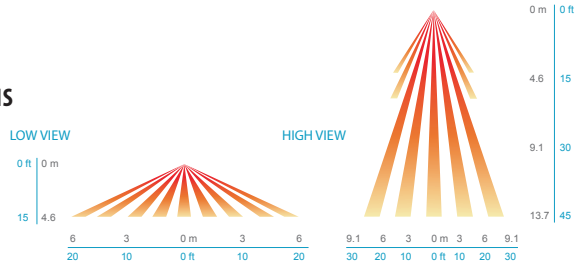
In general, the SBOR 10 is recommended for 8-15 ft (2.44-4.57 m) mounting and provides a coverage area radius for walking motion of greater than 2x the mounting height. The SBOR 10 ODP is ideal for parking garage and low pole mount applications. When mounted 10 ft high, for example, on a luminaire in a parking garage, the sensor's coverage for walking motion extends out 30 ft in a 360º pattern. This closely matches the lighting distribution of a typical parking garage luminaire. When mounted to a light pole, for example, in a parking lot or along a path, the sensor provides 270º of coverage (90º is blocked by the pole). Note, walking askew to sensor typically results in earlier detection than walking directly at sensor.



Coverage Pattern of Low Mount Lens Option (SBOR 10)

SITE & AREA LIGHTING / HIGH MOUNT APPLICATIONS

The SBOR 6 is intended for higher pole mount applications, between 15-30 ft (4.57-9.14 m), and provides a coverage area radius for walking motion of 15-20 ft (4.57-6.10 m). When mounted to a pole the sensor provides 270º of coverage (90º is blocked by the pole).



Coverage Pattern of High Mount Lens Option (SBOR 6)

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-705-7378 www.lithonia.com

 Rev. 04/16/2019

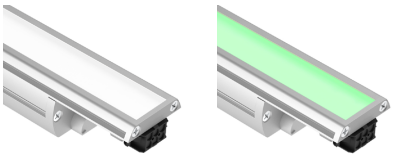
L13

MARK ARCHITECTURAL LIGHTING

SPECIFICATIONS

TYPE:

PROJECT:



MARKCOVE

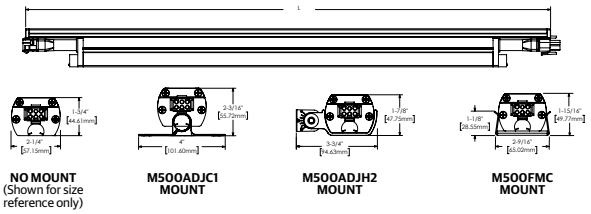
LINEAR COVE
STATIC WHITE & COLOR

HIGHLIGHTS

- Small, versatile and impactful
- Extruded aluminum construction
- Wide 120 x 120 distribution
- Static White available in 2700, 3000, 3500, 4000 or 5000K CCT
- Static Color available in Red, Green, Blue or Amber
- Powerful 300, 450, 600, 750 or 1000 lumens per foot
- Efficient with up to 137 lumens per watt
- Full compliment of mounting and shielding accessories
- Manufactured in USA

DIMENSIONS

Reference Drawing Detail section for additional information



NO MOUNT (Shown for size reference only)

M500ADJC1 MOUNT

M500ADJH2 MOUNT

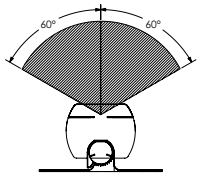
M500FMC MOUNT

LUMEN OUTPUT

MCV502 STATIC WHITE					
Nominal Lumens	**300LMF**	**450LMF**	**600LMF**	**750LMF**	**1000LMF**
Delivered Lumens	354	535	669	847	977
Input Watts	2.63	3.88	4.88	6.25	7.25
Lumens/Watt	135	138	137	136	135

*Based on a 4FT, 80CRI, 40K fixture with standard 120x120 distribution.

STANDARD DISTRIBUTION



120x120 Degree

BAA eldoLED

AcuityBrands.

MARK ARCHITECTURAL LIGHTING

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COVE MOUNTING AND ACCESSORIES TO BE DETERMINED BY ELEC CONTRACTOR. REFER TO ARCHITECTURAL COVE DETAILS.

ORDERING

Example: MCV502 LLP 20FT MSL4 M500FMC 90CRI 40K 1000LMF 120X120DEG MIN1 MVOLT WTP ZT MFCL100TL

Series
- **MCV502** MARKCOVE 502

Linear Plan
- **LLP** Linear Longest Possible
- **LSL** Linear Same Length
- **LCB** Linear Center Balance

Total Run Length
- **_FT** Specify continuous linear feet in 1' increments, with a minimum of 2'. (Example: 24FT)

LENGTH AS SHOWN ON PLAN

Max Section Length
- **MSL2** 2'
- **MSL3** 3'
- **MSL4** 4'

Mounting
- **M500ADJC1** Adjustable Mount Center Axis
- **M500ADJH2** Adjustable Mount Side Hinge
- **M500FMC** Fixed Mount

Mounting Option
- **(blank)** No Cantilever option
- **MCBT6** Cantilever Bracket 6" Projection
- **MCBT12** Cantilever Bracket 12" Projection
- **MCBT18** Cantilever Bracket 18" Projection
- **MCBTL6** Cantilever Bracket Large 6" projection
- **MCBTL12** Cantilever Bracket Large 12" projection
- **MCBTL18** Cantilever Bracket Large 18" projection

Must have M500ADJH2 Mounting selected.

Direct Light Source Color Rendering
- **(blank)** Color LEDs
- **80CRI** 80CRI
- **90CRI*** 90CRI

*Not available in 50K

Direct LED Color Temperature
- **27K** 2700K
- **30K** 3000K
- **35K** 3500K
- **40K** 4000K
- **50K** 5000K
- **AMB** Amber
- **BLU** Blue
- **GRN** Green
- **RED** Red

Direct LED Light Output
- **(blank)** Color LEDs
- **300LMF** 300 Nominal Lumens per Foot
- **450LMF** 450 Nominal Lumens per Foot
- **600LMF** 600 Nominal Lumens per Foot
- **750LMF** 750 Nominal Lumens per Foot
- **1000LMF** 1000 Nominal Lumens per Foot

Distribution
- **120X120DEG** 120 x 120 degrees

Minimum Dimming Level
- **MIN1*** Constant Current, Dimming to 1%
- **DARK**** Constant Current, Dimming to <1%

*Use with ZT Control Input only.
**Use with DALI or DMX Control Input only.

Optional Shielding
- **(blank)** No Shielding
- **MBFC** Baffle Linear Cove (Matte black finish)
- **MGVC** Glare Visor linear Cove (Finish to match housing)

COORDINATE FINISH WITH ARCHITECT

POWER FEED TO BE DETERMINED BY ELECTRICAL CONTRACTOR AND SUPPLIER

Voltage
- **MVOLT** 120-277 Volt

Finish
- **WTP** White Textured Paint
- **SIT** Silver Textured Paint
- **BKT** Black Textured Paint
- **RALTBD** RAL Color TBD
- **CPF** Custom Paint Finish

RALTBD is for pricing only. Replace with applicable RAL number when placing order.

Control Input
- **ZT** 0-10V
- **DALI** DALI
- **DMX*** DMX

*Requires MDPI4W box, purchased separately, for run operation. (See Accessories section starting on page 7.)

Power Feed**
- **M500WBXL** Wire Splice Box, Left Feed, Interior Location, for Conduit Termination
- **M500WBXR** Wire Splice Box, Right Feed, Interior Location, for Conduit Termination
- **MFCL100TL** 100FT Feed Cable Interior Location Left Feed
- **MFCL100TR** 100FT Feed Cable Interior Location Right Feed
- **MFCL10TL** 10FT Feed Cable Interior Location Left Feed
- **MFCL10TR** 10FT Feed Cable Interior Location Right Feed
- **MFCL25TL** 25FT Feed Cable Interior Location Left Feed
- **MFCL25TR** 25FT Feed Cable Interior Location Right Feed
- **MFCL50TL** 50FT Feed Cable Interior Location Left Feed
- **MFCL50TR** 50FT Feed Cable Interior Location Right Feed
- **NOFCL*** No Power Feed Cable

*Requires a Wire Splice Box or Feed Cable, purchased separately, for run operation. (See Accessories section starting on page 7.)
**Consult Fixture Installation Instructions or Basic System Wiring section for Maximum Run Length Limits table to calculate if additional Wire Splice Box or Feed Cables may be required for proper system operation.

Accessories	
Controller (Fresco Control System)	See page 7
Controller (Easyl™ Solo / Touch / Pro)	See page 7
DMX-Power Integrator (required for installation)	See page 7
Feed Cable (required for installation)	See page 7-9
Jumper Cable	See page 9
Wire Splice Box	See page 10
Liquid-Tight Cord Grip	See page 11
Glare Visor	See page 11
Baffle	See page 11
Brackets	See page 11

Model	Length	Weight
MCV502	24-1/4" (616 mm)	3.0 lbs (1.36 kg)
	36-1/8" (918 mm)	3.5 lbs (1.59 kg)
	48" (1219 mm)	4.5 lbs (2.04 kg)

Please reference Basic System Wiring section to ensure all required components are selected for a working system.

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PERFORMANCE DATA

Lumens Per Foot	Fixture Length	Distribution	CCT	CRI	Delivered Lumens	Input Watts	Lumen/ Watt
300	2FT	120x120	40K	80	688	5	138
	3FT	120x120	40K	80	1070	8	134
	4FT	120x120	40K	80	1414	10.5	135
450	2FT	120x120	40K	80	1041	7.5	139
	3FT	120x120	40K	80	1621	11.5	141
	4FT	120x120	40K	80	2140	15.5	138
600	2FT	120x120	40K	80	1302	9.75	134
	3FT	120x120	40K	80	2027	14.75	137
	4FT	120x120	40K	80	2675	19.5	137
750	2FT	120x120	40K	80	1649	12.5	132
	3FT	120x120	40K	80	2567	19	135
	4FT	120x120	40K	80	3389	25	136
1000	2FT	120x120	40K	80	1902	14.5	131
	3FT	120x120	40K	80	2963	22	135
	4FT	120x120	40K	80	3909	29	135

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Actual performance may differ as a result of end-user environment and application. Contact factory for performance data on any configurations not shown here.

Lumen Multipier Table

Data table baseline is 4000K 80CRI photometry. This table can be used to approximate the lumen values at different Kelvin temperatures and Color Rendering Index. Power consumption would stay the same.

CCT	CRI	Multiplier
27K	80	0.960
30K	80	0.991
35K	80	1.000
40K	80	1.000
50K	80	1.103
27K	90	0.815
30K	90	0.833
35K	90	0.854
40K	90	0.869

Color	Fixture Length	Distribution	Delivered Lumens	Input Watts	Lumen/ Watt	Delivered Lumens Per Foot	Input Watts Per Foot
RED	2FT	120x120	765	11.01	69	383	5.51
	3FT	120x120	1192	15.59	76	397	5.20
	4FT	120x120	1622	20.52	79	406	5.13
GREEN	2FT	120x120	1860	13.5	138	930	6.75
	3FT	120x120	2898	19.13	151	966	6.38
	4FT	120x120	3943	25.18	157	986	6.30
BLUE	2FT	120x120	546	14.9	37	273	7.45
	3FT	120x120	851	21.11	40	284	7.04
	4FT	120x120	1157	27.79	42	289	6.95
AMBER	2FT	120x120	679	11.37	60	340	5.69
	3FT	120x120	1058	16.1	66	353	5.37
	4FT	120x120	1439	21.19	68	360	5.30

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Actual performance may differ as a result of end-user environment and application. Contact factory for performance data on any configurations not shown here.

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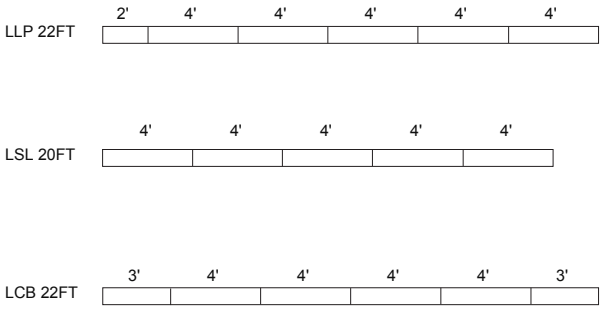
LINEAR PLAN

Mark offers the ability to provide a continuous run plan to suit your requirements by optionally offering three methods of configuration.

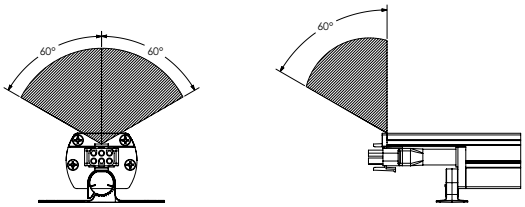
LLP Longest Length Possible:
In this plan the longest length available is optimized resulting in the fewest segments and mounting locations. Caution should be used where balanced appearance is a concern. Example: 22FT row would have (5) 4FT segments and (1) 2FT segment located at one end.

LSL Longest Same Length:
In this configuration each segment is the same length is standardized based on the longest length available and is the only option provided. Because it is dependent on one segment length there are mathematical limitations on what overall row lengths can be achieved. Example: 20FT row would be achieved with (5) 4FT long segments equaling 20FT (nominal).

LCB Longest Center Balanced:
This configuration incorporates the longest center segment(s) along with any additional lengths required to fill located at each end. Example: 22FT row would have (2) 3FT segments (one at each end) and (4) 4FT intermediate segments located in between.



DISTRIBUTION



120x120 Degree

MARK ARCHITECTURAL LIGHTING

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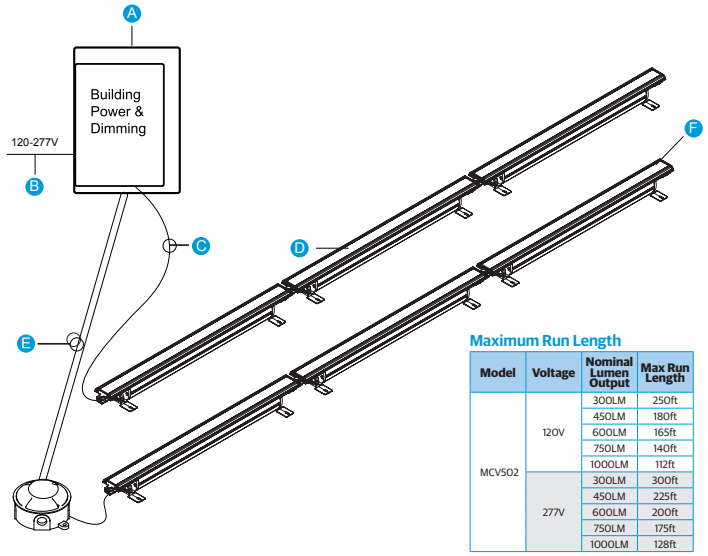
Linear Cove
Static White & Color

BASIC SYSTEM WIRING INFORMATION WITHOUT DMX

This very basic system wiring diagram provides an overview of components and materials required for a simple installation of MCV502 luminaires controlled by building system power (By Others). These diagrams should not be used in place of actual installation instructions or submittal drawings prepared for a specific project.

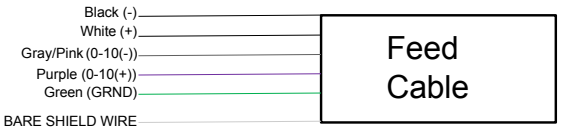
Interior application shown.



Maximum Run Length

Model	Voltage	Nominal Lumen Output	Max Run Length
MCV502	120V	300LM	250ft
		450LM	180ft
		600LM	165ft
		750LM	140ft
		1000LM	112ft
	277V	300LM	300ft
		450LM	225ft
		600LM	200ft
		750LM	175ft
		1000LM	128ft

Feed Cable Wiring



*Notes

1) Cap BARE SHIELD WIRE in Junction box. (By Others)
2) When not using 0-10V dimming, cap Gray/Pink and Purple separately in the junction box. (By Others)

Luminaire installation can be as simple as a single luminaire and one control to many different luminaires in multiple locations being triggered and manipulated in real time. Consulting with the factory at the beginning stages of the project will ensure the required equipment be specified and properly installed.

A Building power and dimming control input via 0-10V or DALI system provided by others.

B 120V-277V input. Metallic conduit and standard fittings are compatible as are multi-conductor cords provided they are appropriate to the mounting location.

C Feed cable connects junction box or control input with first fixture in a run. 14 ga. conductors carry power, shielded 18 ga. conductors carry data. Input end is stripped for connection to the junction box, output end includes a female or male plug for fixture connection. Also included with each feed cable is a sealing cap for the end of each run.

D Reference Maximum Run Length limits table for connection to a single feed cable.

E Power can be run to junction box locations in rigid conduit. Use Belden 9829 for data and copper wire per local code for power. Use appropriate fitting for combination cord.

F Included with each feed cable is a sealing cap for the last luminaire in each run. See installation instructions.

MARK ARCHITECTURAL LIGHTING

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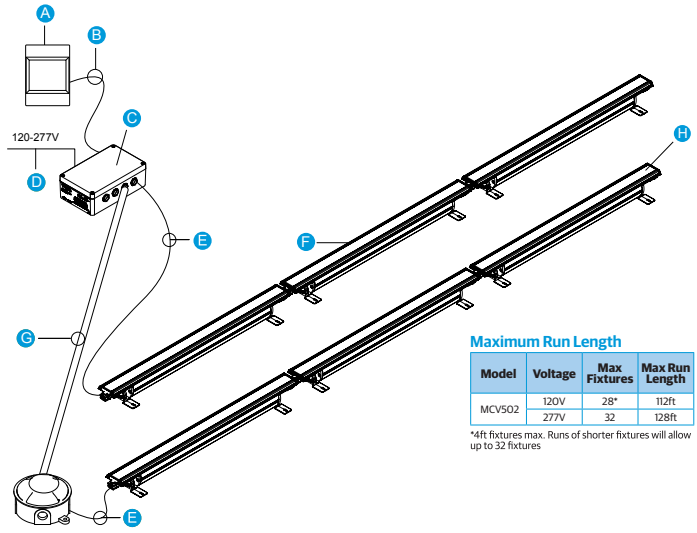
BASIC SYSTEM WIRING INFORMATION WITH DMX

This very basic system wiring diagram provides an overview of components and materials required for a simple installation of MCV502 luminaires controlled by a DMX controller. These diagrams should not be used in place of actual installation instructions or submittal drawings prepared for a specific project.

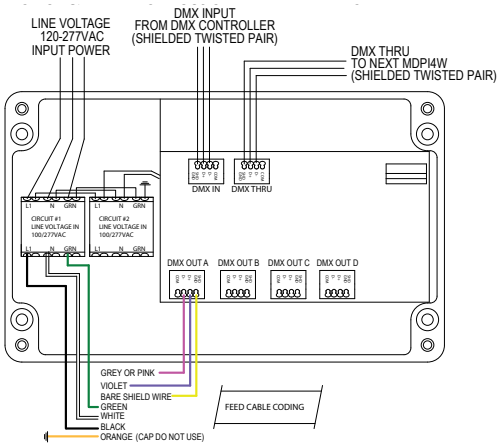


Maximum Run Length

Model	Voltage	Max Fixtures	Max Run Length
MCV502	120V	28*	112ft
	277V	32	128ft

*4ft fixtures max. Runs of shorter fixtures will allow up to 32 fixtures

Power & DMX Connection in MDPI4W Box



A dynamic luminaire installation can be as simple as a single luminaire and one control to many different luminaires in multiple locations being triggered and manipulated in real time. Consulting with the factory at the beginning stages of the project will ensure the required equipment be specified and properly installed.

Note: For multiple runs and multiple MDPI4W boxes, consult factory.

Note: No more than four MDPI4W Boxes, in series, can be utilized between the DMX Controller and any luminaire.

A DMX controller providing one universe of DMX-512 control.

To supply a complete system RDM set-up and playback control solution, use:

Easyl
- Three versions available from entry-level to show creation using computer software
- Full color LCD touchscreen
- Recall colors, shows, and effects with one touch

Fresco
- Manage multiple light sources in multiple lighting zones, all from one controller
- On screen lighting design and set-up, no computer required or Ethernet connection for remote configuration and advanced control
- All device settings are stored on-board in non-volatile memory

B Belden 9829 cable is the preferred communication/ data cable used to carry the DMX signal to and from the MDPI4W Box. The total length of this cable must not exceed 1000 feet from the DMX controller to the MDPI4W Box. No luminaires should be installed between DMX Controller and any MDPI4W Box.

C MDPI4W box (Data Power Integration) is used to bundle DMX to line voltage and deliver them to the luminaire. This box provides necessary isolation between the DMX control and line voltage and is required for all MCV502 installations. The MDPI4W box also serves as a 4-channel splitter enabling up to 128 fixtures to be controlled from a single MDPI4W box. Refer to MDPI4W spec sheet for dimensions and mounting details.

D 120V-277V input to MDPI4W box. Metallic conduit and standard fittings are compatible as are multi-conductor cords provided they are appropriate to the mounting location.

E Feed cable connects junction box with first fixture in a run. 14 ga. conductors carry power, shielded 18 ga. conductors carry data. Input end is stripped for connection to the Junction or MDPI4W box, output end includes a male or female plug for fixture connection. Also included with each feed cable is a termination/ sealing cap for the end of each run. Contact factory for availability of custom feed cable lengths.

F A maximum of 32 luminaires can be connected to a single output channel of the MDPI4W box. The maximum length of cord and luminaire run combined is 1000 feet per DMX/RDM specification.

G Power and Data can be run to junction box locations in rigid conduit. Use Belden 9829 for data and copper wire per local code for power. Use appropriate fitting for combination cord.

H To ensure data integrity, a termination/sealing cap with 120 Ohm resistor is required at the last luminaire in each run. See installation instructions.

Easyl Controller

Fresco Control System

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ACCESSORY OPTIONS

Fresco Control System

Series		Model		Options		Finish	
FCS	Fresco Control System	**7TSN**	7" touchscreen with nLight port	**(blank)**	nlight only	**DBL**	Black
				X	DMX/RDM control	**DWH**	White
						DNA	Natural Aluminum

Refer to FRESCO spec sheet for additional details and options.

Easyl™ LED Show Controller with LCD touchscreen (integral power supply)

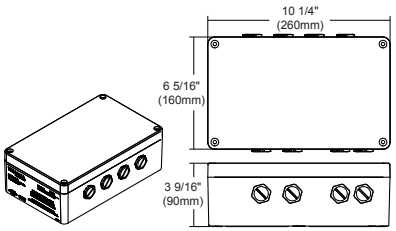
Series		Voltage		Finish	
EZSOLO	Easyl Solo	**MVOLT**	120V-277V VAC, 50/60 Hz	**BK**	Black
EZTOUCH	Easyl Touch			**WH**	White
EZPRO	Easyl Pro				

Refer to EASYL spec sheet for additional details and options.

DMX / Power Integrator

Model	
MDPI4W	MDPI4W-DMX/POWER INTEGRATOR BOX (Must be purchased separately)

Refer to MDPI4W spec sheet for additional details.



Integrates DMX signal & 120-277 line voltage onto a single cable. Exterior rated, up to 4 output feeds, Silver Textured Finish.

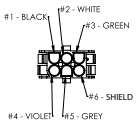
Environmental Information

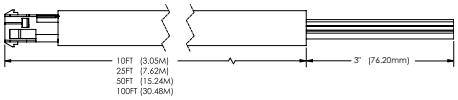
Storage Temperature	40˚F - 185˚F
Start-up Temperature	13˚F - 122˚F
Operating Temperature	13˚F - 122˚F
Ingress Protection Rating	IP65
Environment	Suitable for indoor and outdoor applications

Feed Cable, Right Feed (Female Plug)
***Minimum of one feed cable, left or right, required per installation**

Model	
MFCL10TR BCRD DXP	10FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (Black)
MFCL25TR BCRD DXP	25FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (Black)
MFCL50TR BCRD DXP	50FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (Black)
MFCL100TR BCRD DXP	100FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (Black)
MFCL10TR WCRD DXP	10FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (White)
MFCL25TR WCRD DXP	25FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (White)
MFCL50TR WCRD DXP	50FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (White)
MFCL100TR WCRD DXP	100FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (White)

Carries DMX signal and 120-277 line voltage power to right end of first fixture in run. Supplied with termination/sealing cap. *Use one feed cable per run only.*





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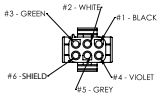
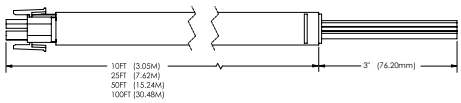
ACCESSORY OPTIONS (CONTINUED)

Feed Cable, Left Feed (Male Plug)
***Minimum of one feed cable, left or right, required per installation**

Model	
MFCL10TL BCRD DXP	10FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (Black)
MFCL25TL BCRD DXP	25FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (Black)
MFCL50TL BCRD DXP	50FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (Black)
MFCL100TL BCRD DXP	100FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (Black)
MFCL10TL WCRD DXP	10FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (White)
MFCL25TL WCRD DXP	25FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (White)
MFCL50TL WCRD DXP	50FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (White)
MFCL100TL WCRD DXP	100FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (White)

Carries DMX signal and 120-277 line voltage power to left end of first fixture in run.
Supplied with termination/sealing cap.
Use one feed cable per run only.

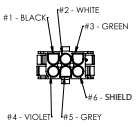


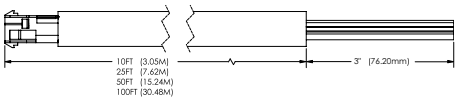


Feed Cable, Right Feed (Female Plug)
***Minimum of one feed cable, left or right, required per installation**

Model	
MFCL10TR BCRD NDXP	10FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (Black)
MFCL25TR BCRD NDXP	25FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (Black)
MFCL50TR BCRD NDXP	50FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (Black)
MFCL100TR BCRD NDXP	100FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (Black)
MFCL10TR WCRD NDXP	10FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (White)
MFCL25TR WCRD NDXP	25FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (White)
MFCL50TR WCRD NDXP	50FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (White)
MFCL100TR WCRD NDXP	100FT Feed Cable w/ Sealing Cap, Right Feed, Interior Location (White)

Carries NON-DMX signal and 120-277 line voltage power to right end of first fixture in run.
Supplied with termination/sealing cap.
Use one feed cable per run only.





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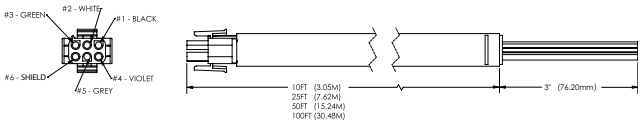
Linear Cove
Static White & Color

ACCESSORY OPTIONS (CONTINUED)

Feed Cable, Left Feed (Male Plug)
***Minimum of one feed cable, left or right, required per installation**

Model	
MFCL10TL BCRD NDXP	10FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (Black)
MFCL25TL BCRD NDXP	25FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (Black)
MFCL50TL BCRD NDXP	50FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (Black)
MFCL100TL BCRD NDXP	100FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (Black)
MFCL10TL WCRD NDXP	10FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (White)
MFCL25TL WCRD NDXP	25FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (White)
MFCL50TL WCRD NDXP	50FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (White)
MFCL100TL WCRD NDXP	100FT Feed Cable w/ Sealing Cap, Left Feed, Interior Location (White)

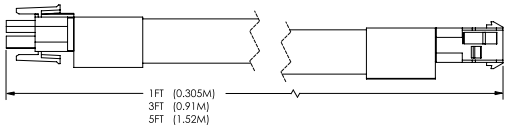
Carries NON-DMX signal and 120-277 line voltage power to left end of first fixture in run.
Supplied with termination/sealing cap.
Use one feed cable per run only.



Jumper Cable *Optional*

Model	
MJCLW1T BCRD	1FT Jumper Cable Interior Location (Black)
MJCLW3T BCRD	3FT Jumper Cable Interior Location (Black)
MJCLW5T BCRD	5FT Jumper Cable Interior Location (Black)
MJCLW1T WCRD	1FT Jumper Cable Interior Location (White)
MJCLW3T WCRD	3FT Jumper Cable Interior Location (White)
MJCLW5T WCRD	5FT Jumper Cable Interior Location (White)

Carries DMX or NON-DMX signal and 120-277 line voltage power between two units in a run when larger spacing between units is required.



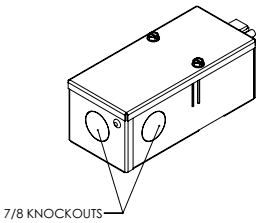
MARK ARCHITECTURAL LIGHTING

MARKCOVE
Linear Cove
Static White & Color

ACCESSORY OPTIONS (CONTINUED)

Wire Splice Box, Right Feed (Female Plug), *Optional*
*Minimum of one wire splice box, left or right, required for installation

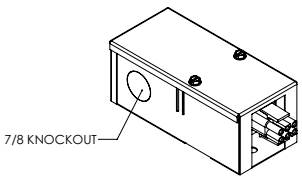
Model	
M500WBXR DXP	Wire Splice Box w/ Sealing Cap, Right Feed, Interior Location (Galvanized Steel)
M500WBXR WTPP DXP	Wire Splice Box,w/ Sealing Cap, Right Feed, Interior Location (White)



Replaces feed cable for areas where flexible cord cannot be used to bring input DMX signal and 120-277 line voltage power to right end of beginning of run. Box allows 1/2" NPT conduit fitting connection and area for building wire splice connections. Supplied with termination/sealing cap.
Use one wire splice box per run only.

Wire Splice Box, Left Feed (Male Plug), *Optional*
*Minimum of one wire splice box, left or right, required for installation

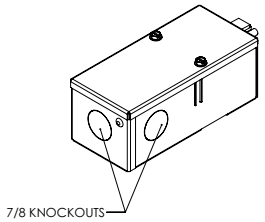
Model	
M500WBXL DXP	Wire Splice Box,w/ Sealing Cap, Left Feed, Interior Location (Galvanized Steel)
M500WBXL WTPP DXP	Wire Splice Box,w/ Sealing Cap, Left Feed, Interior Location (White)



Replaces feed cable for areas where flexible cord cannot be used to bring input DMX signal and 120-277 line voltage power to right end of beginning of run. Box allows 1/2" NPT conduit fitting connection and area for building wire splice connections. Supplied with termination/sealing cap.
Use one wire splice box per run only.

Wire Splice Box, Right Feed (Female Plug), *Optional*
*Minimum of one wire splice box, left or right, required for installation

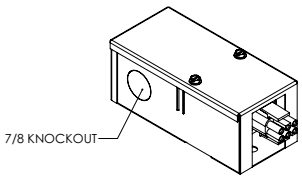
Model	
M500WBXR NDXP	Wire Splice Box w/ Sealing Cap, Right Feed, Interior Location (Galvanized Steel)
M500WBXR WTPP NDXP	Wire Splice Box,w/ Sealing Cap, Right Feed, Interior Location (White)



Replaces feed cable for areas where flexible cord cannot be used to bring input NON-DMX signal and 120-277 line voltage power to right end of beginning of run. Box allows 1/2" NPT conduit fitting connection and area for building wire splice connections. Supplied with termination/sealing cap.
Use one wire splice box per run only.

Wire Splice Box, Left Feed (Male Plug), *Optional*
*Minimum of one wire splice box, left or right, required for installation

Model	
M500WBXL NDXP	Wire Splice Box,w/ Sealing Cap, Left Feed, Interior Location (Galvanized Steel)
M500WBXL WTPP NDXP	Wire Splice Box,w/ Sealing Cap, Left Feed, Interior Location (White)



Replaces feed cable for areas where flexible cord cannot be used to bring input NON-DMX signal and 120-277 line voltage power to right end of beginning of run. Box allows 1/2" NPT conduit fitting connection and area for building wire splice connections. Supplied with termination/sealing cap.
Use one wire splice box per run only.

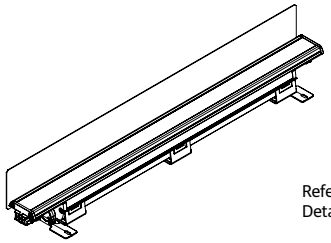
MARK ARCHITECTURAL LIGHTING

MARKCOVE
Linear Cove
Static White & Color

ACCESSORY OPTIONS (CONTINUED)

Glare Visor (Linear) *Optional*

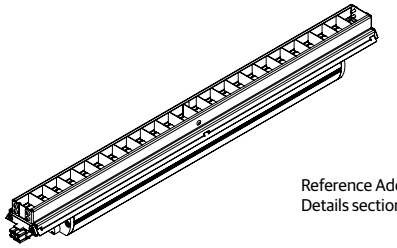
Model		Fixture Section		Finish	
MGVC5	Glare Visor Linear Cove	**U2**	2FT Length Unit	**BKT**	Black Textured Paint
		U3	3FT Length Unit	**SIT**	Silver Textured Paint
		U4	4FT Length Unit	**WTP**	White Textured Paint
				RALTBD	RAL Paint Finish
				CPF	Custom Painted Finish



Reference Additional Accessory Details section for dimensions

Baffle (Linear) *Optional*

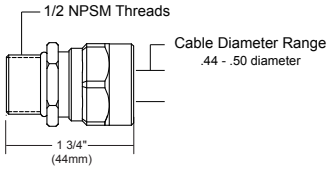
Model		Fixture Section	
MBFC5	Baffle Linear Cove (Available in matte black finish only)	**U2**	2FT Length Unit
		U3	3FT Length Unit
		U4	4FT Length Unit



Reference Additional Accessory Details section for dimensions

Liquid-Tight Cord Grip *Optional*

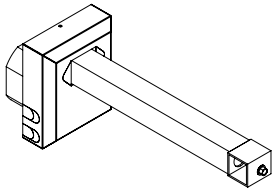
Model	
MCORDGP2	Liquid-Tight Cord Grip (Use to secure and seal feed cord to MDPI4W Box)



Connector to secures and seal feed cord.

Brackets *Optional*

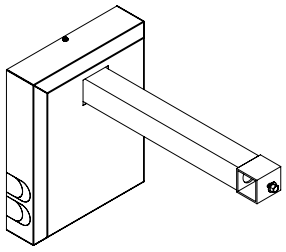
Series		Finish	
MCBT6	Cantilever Bracket 6" Projection	**BKT**	Black Textured Paint
MCBT12	Cantilever Bracket 12" Projection	**SIT**	Silver Textured Paint
MCBT18	Cantilever Bracket 18" Projection	**WTP**	White Textured Paint
		RALTBD	RAL Paint Finish
		CPF	Custom Painted Finish



Reference Additional Accessory Details section for dimensions

Brackets *Optional*

Series		Finish	
MCBTL6	Cantilever Bracket Large 6" Projection	**BKT**	Black Textured Paint
MCBTL12	Cantilever Bracket Large 12" Projection	**SIT**	Silver Textured Paint
MCBTL18	Cantilever Bracket Large 18" Projection	**WTP**	White Textured Paint
		RALTBD	RAL Paint Finish
		CPF	Custom Painted Finish



For use with surface mount junction box (by others) and surface mounted conduit (by others).

Reference Additional Accessory Details section for dimensions

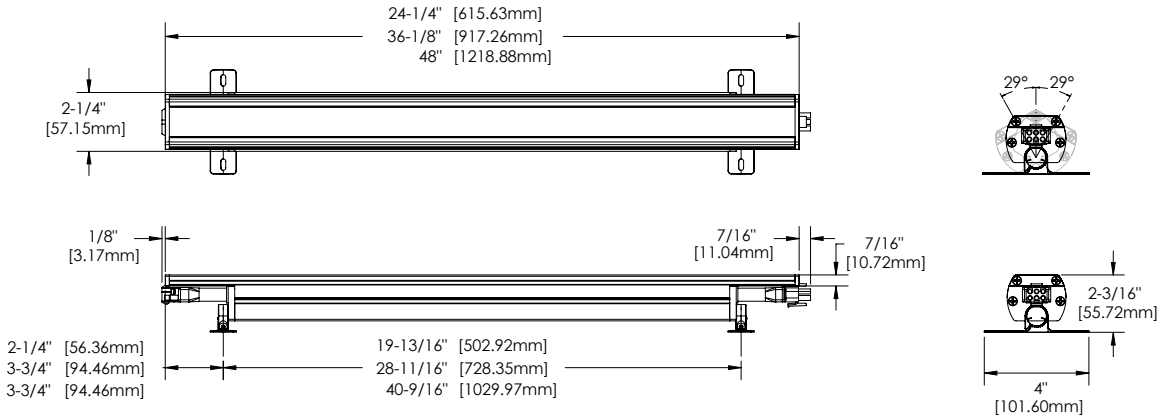
MARK ARCHITECTURAL LIGHTING

MARKCOVE

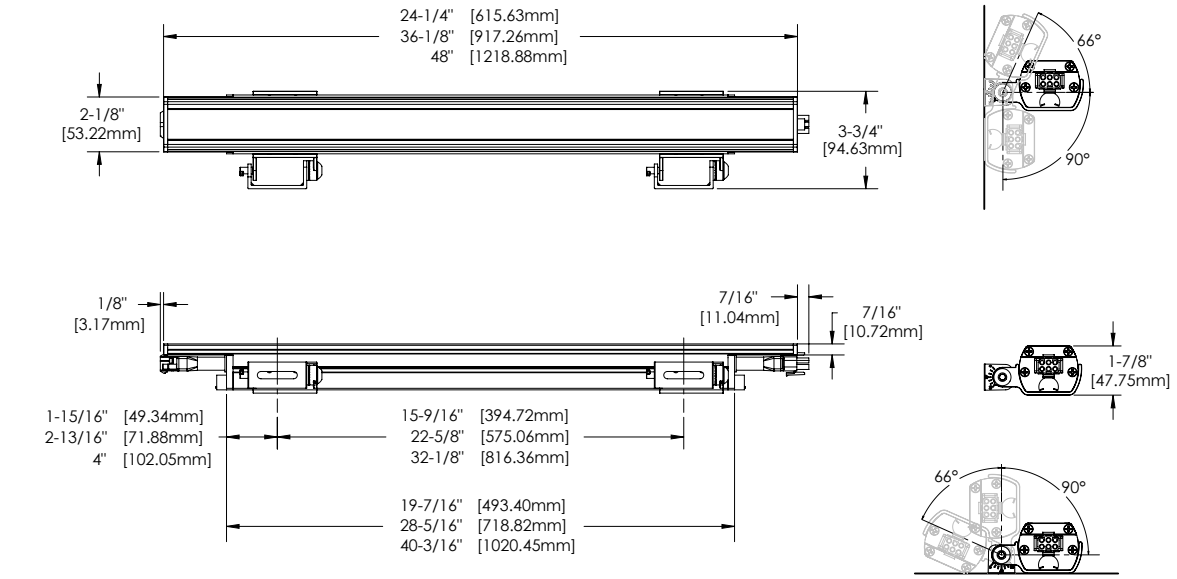
Linear Cove
Static White & Color

DRAWING DETAILS

M500ADJC1 - Adjustable Mount Center Axis



M500ADJH2 - Adjustable Mount Side Hinge



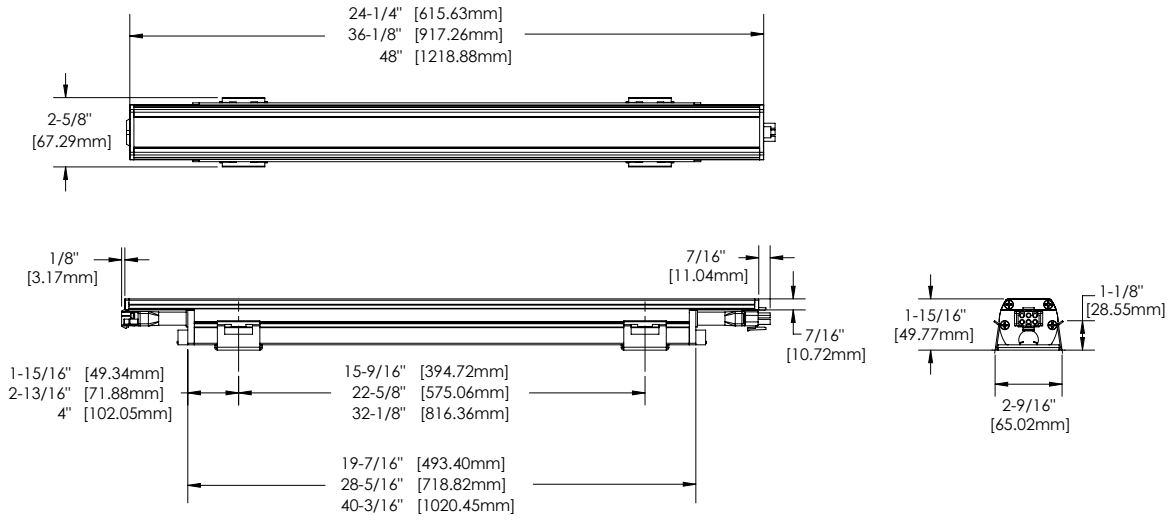
MARK ARCHITECTURAL LIGHTING

MARKCOVE

Linear Cove
Static White & Color

DRAWING DETAILS (CONTINUED)

M500FMC - Fixed Mount

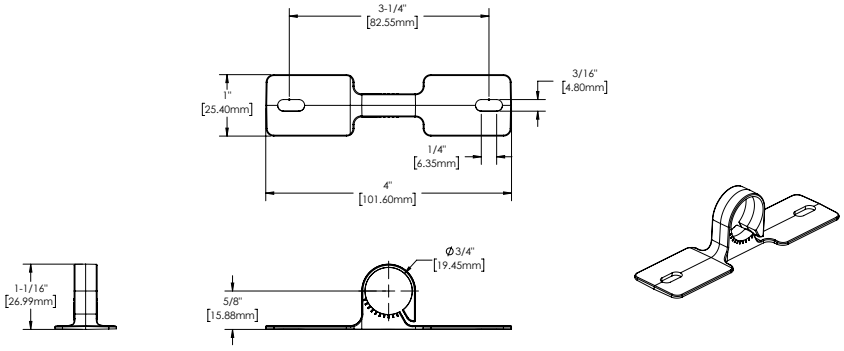


MARK ARCHITECTURAL LIGHTING

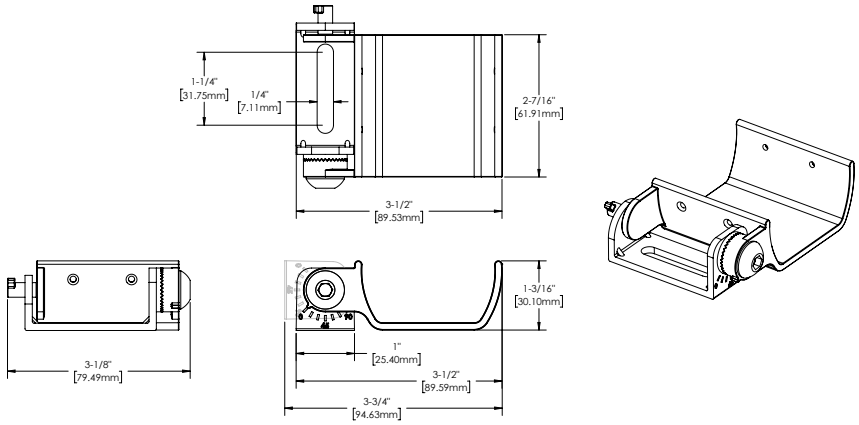
MARKCOVE
Linear Cove
Static White & Color

DRAWING DETAILS (CONTINUED)

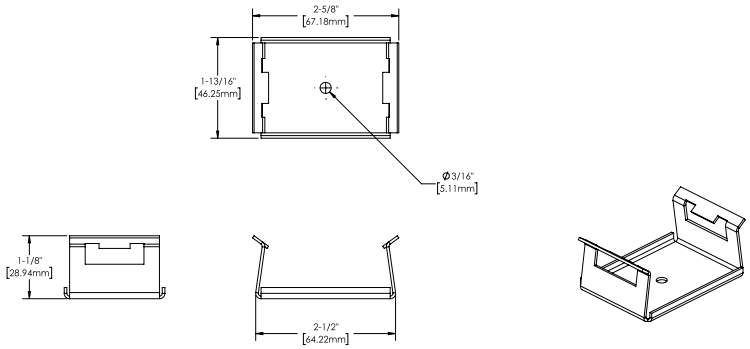
M500ADJC1 - Adjustable Mount Center Axis Detail



M500ADJH2 - Adjustable Mount Side Hinge Detail



M500FMC - Fixed Mount Detail

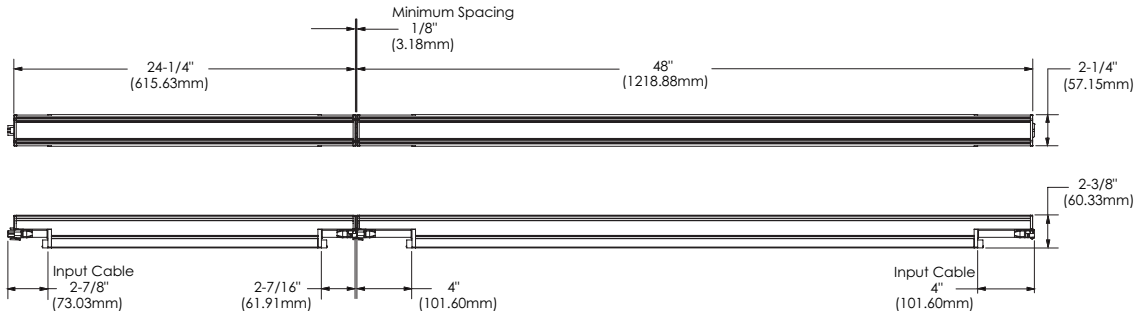


MARK ARCHITECTURAL LIGHTING

MARKCOVE
Linear Cove
Static White & Color

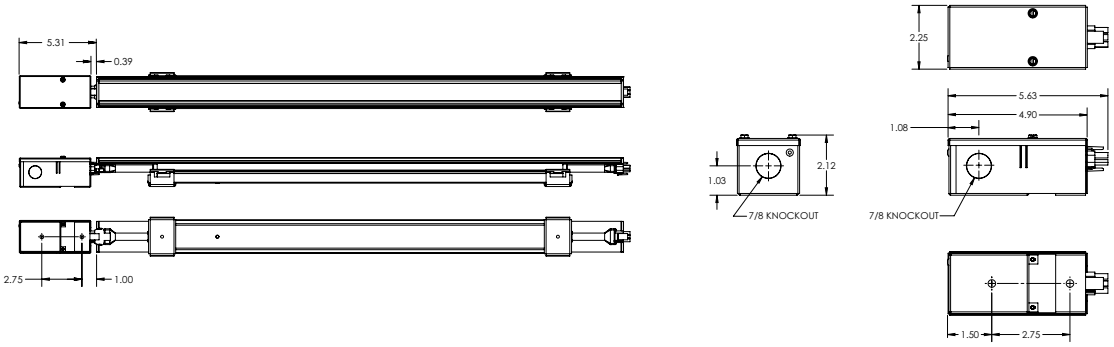
DRAWING DETAILS (CONTINUED)

MCV502 Series Typical End-To-End Run Configuration

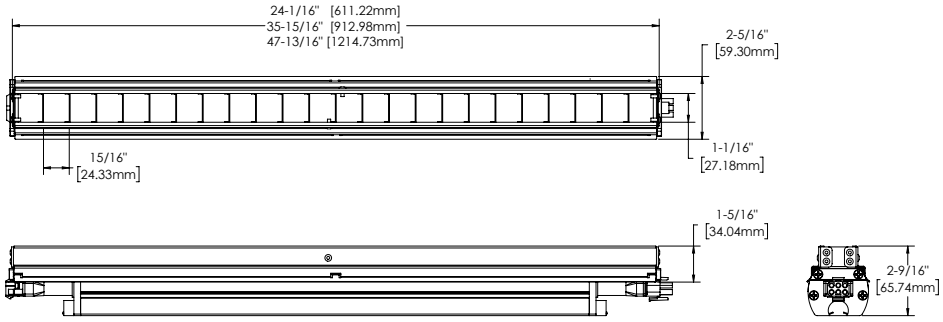


ADDITIONAL ACCESSORY DETAILS

M500WBX Details
(Same dimensions apply for Left or Right Feed)



Baffle Linear Cove

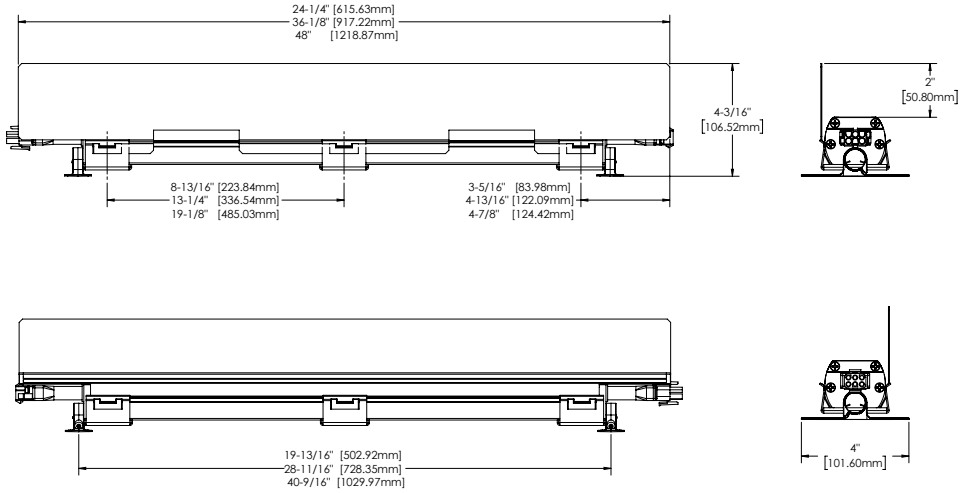


MARK ARCHITECTURAL LIGHTING

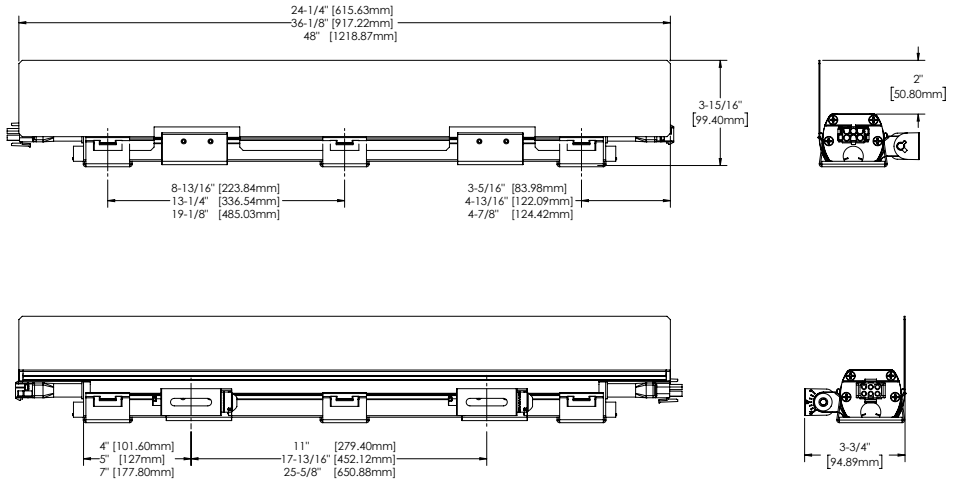
MARKCOVE
Linear Cove
Static White & Color

ADDITIONAL ACCESSORY DETAILS (CONTINUED)

Glare Visor with M500ADJC1 Mount



Glare Visor with M500ADJH2 Mount



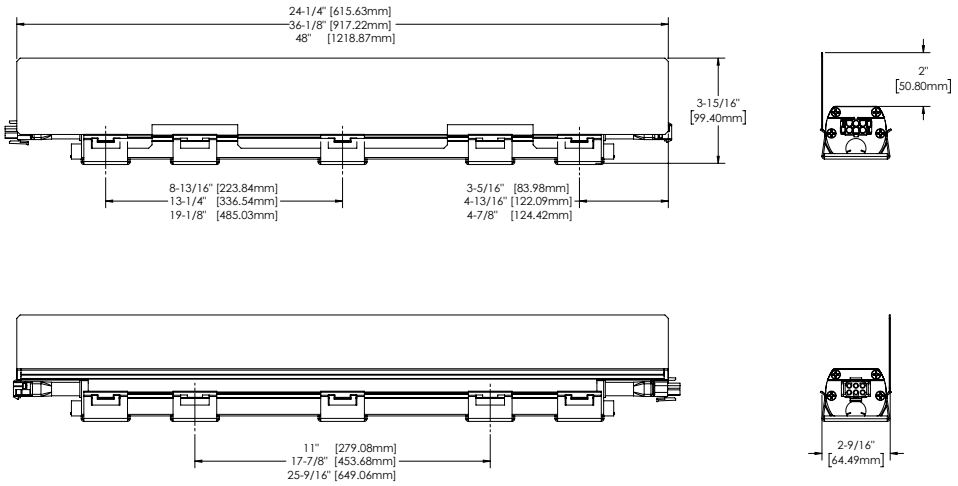
MARK ARCHITECTURAL LIGHTING

MARKCOVE

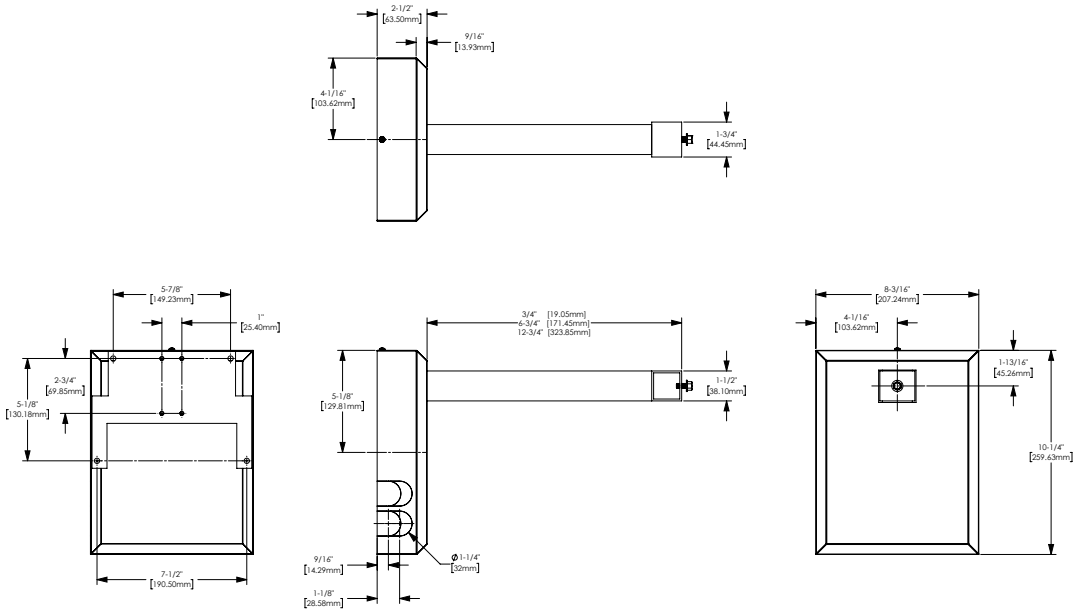
Linear Cove
Static White & Color

ADDITIONAL ACCESSORY DETAILS (CONTINUED)

Glare Visor with M500FMC Mount



Cantilever Bracket Large Detail

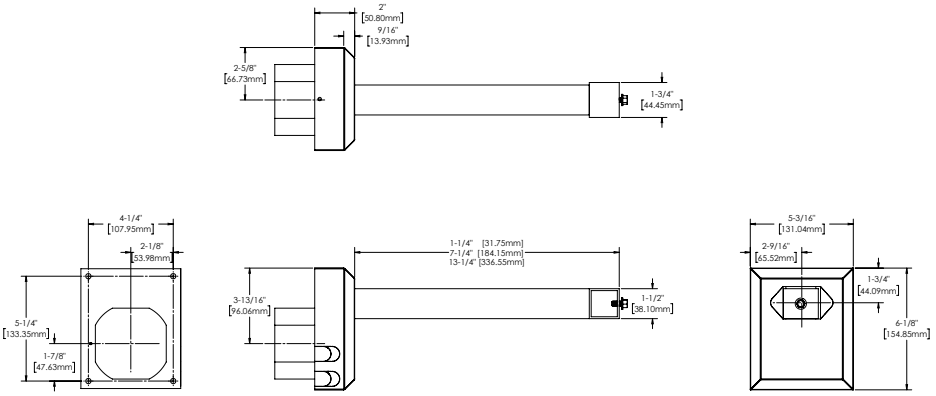


MARK ARCHITECTURAL LIGHTING

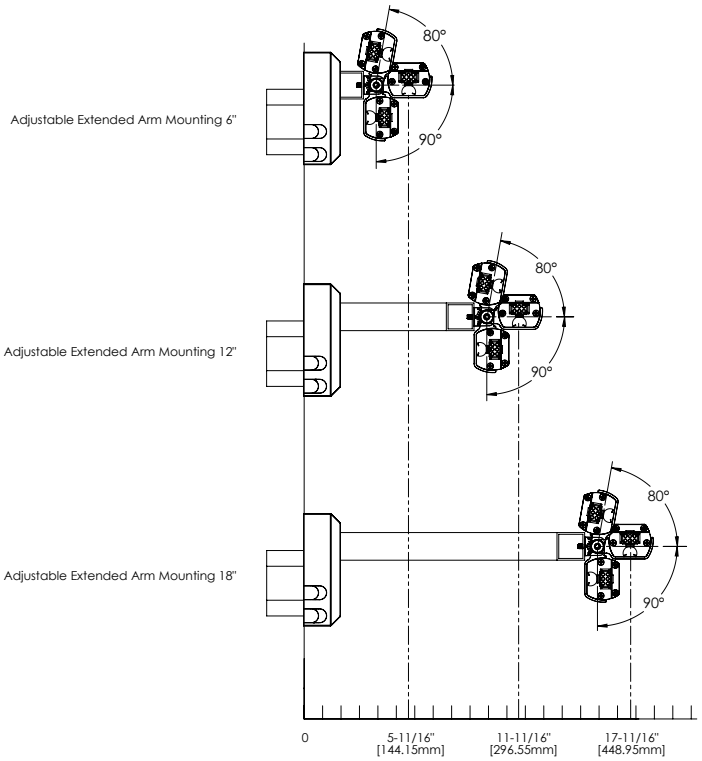
MARKCOVE
Linear Cove
Static White & Color

ADDITIONAL ACCESSORY DETAILS (CONTINUED)

Cantilever Bracket Detail



Cantilever Bracket Detail with M500ADJH2 and Fixture



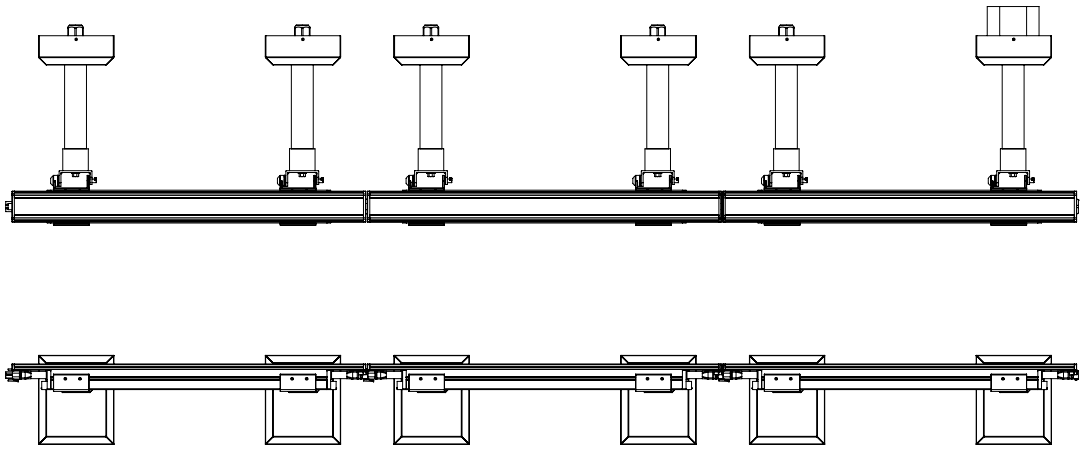
MARK ARCHITECTURAL LIGHTING

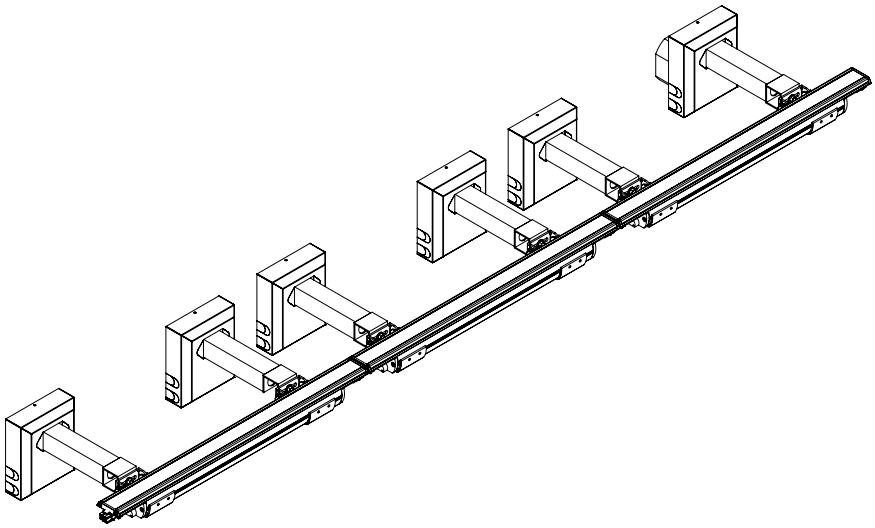
MARKCOVE

Linear Cove
Static White & Color

ADDITIONAL ACCESSORY DETAILS (CONTINUED)

MCV502 Series Typical End-To-End Run Configuration with Cantilever Brackets (Showing 6-foot run of (3) 2-foot units with MCBT12 bracket accessory





MARK ARCHITECTURAL LIGHTING

MARKCOVE
Linear Cove
Static White & Color

SPECIFICATIONS

Voltage: 120 through 277v/60Hz

Distribution: 120° x 120°

Size: 2.25W x 1.75H

Housing: Extruded aluminum snap together construction

Finish: Polyester powder coat painted finish. Black oxide fastener color with BKT finish and natural stainless steel fastener color with WTP & SIT finishes

Lens Material: Extruded acrylic with frosted surface

Lumen Maintenance: 60,000 hours L70 @ +55deg C for static white 120,000 hours L70 @ +55deg C for color

LED Color Mix: 12 LEDs diodes per foot

Dominant Wavelengths: RED (627nm), GREEN (530nm), BLUE (466nm), AMBER (590nm)

Control System: 0-10V dimmer control or for DMX operation, Easyl or Fresco DMX512 controller

Resolution(DMX/RDM): Resolution is set per fixture and addressed independently.

Ambient Temperature Ranges: -40° to +45°C

Mounting: Suitable for mounting within the space between ground and 4FT (1.2M) of the ground. Suitable for damp location applications.

Certification/Compliance: CSA Certified to meet U.S. and Canadian standards conforming to UL 1598 and CAN/CSA C22.2 No. 250.0

Weight: 24" - 3.0 lbs (1.36 kg) / 36" - 3.5 lbs (1.59 kg) / 48" - 4.5 lbs (2.04 kg)

Buy American Act: This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations. Please refer to www.acuitybrands.com/resources/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.

Assembled in America: Buy American Act Compliant

DECO® | LIGHTING

Client:_____ Order #:_____
Project Name:_____ Type:_____ Qty:_____

DACH-LED Round

Architectural LED Channel

L14

TEMPERSWITCH™ 3500 | 4000 | 5000

DEFENDER series

DLC Listed | cULus Listed | 10 Yr Warranty Available

Performance Data

CRI
80+

CCT
3500K,4000K, 5000K

Projected Lifetime
>173,000 Hours (L70);
>50,000 Hours (L90)

Dimming
0-10V Dimming Standard,
100% down to 10%

Operating Temperature
-20°C to 40°C Ambient

UL Listed
cULus, Suitable for dry and damp locations

Warranty
5 year Standard
10 year Optional

Description

The DACH-LED round series is a functional and multi-purpose channel family that incorporates premium performance and construction durability. The performance and application versatility makes this fixture usable in every application. This fixture can be installed using various mounting methods and numerous options and accessories are available (see Page 3). The DACH-LED round series can be the illumination solution in commercial, industrial, institutional and retail applications. An excellent choice for storage/utility areas, coves, display cases, shops, task and general area lighting.

Features

- Die formed channel.
- Powder coated white enamel finish after fabrication.
- Numerous KOs for easy installation.
- Also available in tandem 8' lengths, & tandem wired 16' lengths.
- UL listed for damp location
- LED driver is 0-10V dimming standard.
- Operating Temperature: -20°C to 40°C Ambient
- OPTICS: Architectural frosted diffuse lens eliminates pixelation, improves uniformity and minimizes glare.
- Performs at up to 130 lumens per watt; CRI: 80+
- Temperswitch allows users to select between 5000K, 4000K, and 3500K in the field by simply switching an easily accessible three position switch. Fixture comes set/standard at 40K.
- For DECO MESH please review DECO MESH spec sheet

DACH-LED (A) ____ (B) ____ (C) **354050** (D) **U** (E) **R** (F) ____ (G) ____ (H)

Ordering Information

A FIXTURE SERIES

DACH-LED	Round Architectural LED Channel Luminaire

B LENGTH

2	2'
4	4'
8	8'

C WATTAGE/LUMENS (LENGTH 2)

22	22W/2350[1]

WATTAGE/LUMENS (LENGTH 4)

22	22W/2860[1]
28	28W/3640[1]
36	36W/4680[1]
44	44W/5720[1]

(LENGTH 8)

48	48W/6240[1]
68	68W/8840[1]
90	90W/11700[1]

D CCT

354050	3500K-4000K-5000K

E VOLTAGE

U	120-277V

F HOUSING

R	Round

G OPTIONS

E	Emergency
M	Motion Sensor[2]

H WARRANTY[3]

-	5 Year Warranty
10	10 Year Warranty
10L	10 Year Warranty including labor

[1] Delivered Lumens (4000K)
[2] For more information on the Motion Sensor features and benefits see Page 3
[3] 5 Year Warranty is Standard unless specified

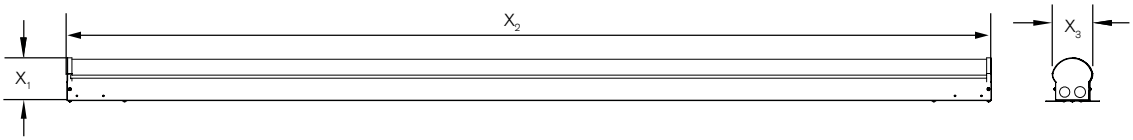
2917 Vail Ave.
Commerce Ca 90040
www.getdeco.com
info@getdeco.com
t: (800) 613-DECO
f: (310)366-6855

PARTNERS 21-146A
LUMINAIRE PRODUCT DATA
265700 - 118

DACH-LED Round Architectural LED Channel

Digitize your light.

Dimensions

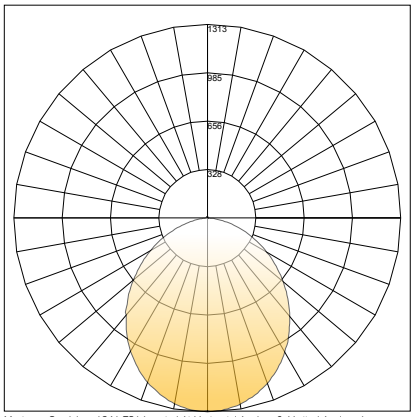


	X_1	X_2	X_3
4'	3.59"	47.63"	2.87"
8'	3.59"	92.91"	2.87"

Photometric

POLAR GRAPH

DACH-LED-36-35050-U-R



Maximum Candela = 1341.781 Located At Horizontal Angle = 0, Vertical Angle = 1
1 - Vertical Plane Through Horizontal Angles (0 - 180) (Through Max. Cd.)

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

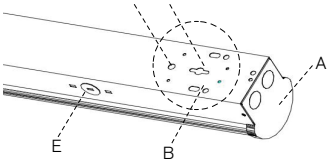
Effective Floor Cavity Reflectance 0.20

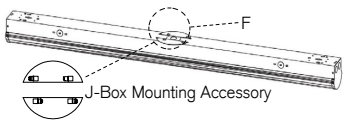
RC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	177	177	177	177	113	113	113	113	106	106	106	100	100	100	94	94	94	92
1	105	99	94	89	101	96	91	87	90	86	83	85	82	79	80	77	75	72
2	95	85	78	71	91	83	76	70	78	72	67	73	68	64	69	65	62	59
3	86	75	66	59	83	72	64	58	68	61	55	64	58	54	61	56	52	49
4	78	66	57	50	75	64	55	49	60	53	47	57	52	46	54	48	44	42
5	72	59	49	42	59	57	48	42	54	46	41	51	44	39	48	43	38	36
6	66	53	44	37	64	51	43	36	49	41	35	46	40	34	44	38	33	31
7	62	48	39	32	59	47	38	32	44	37	31	42	35	30	40	34	30	28
8	57	44	35	29	55	42	34	29	40	33	28	39	32	27	37	31	27	25
9	54	40	32	26	52	39	31	26	37	30	25	36	29	25	34	28	24	22
10	50	37	29	23	48	36	28	23	34	28	23	33	27	22	32	26	22	20

LUMINANCE DATA (cd/sq.m)

Angle In Degrees	Angle In Degrees	Angle In Degrees	Angle In Degrees
45	13954	7851	7168
55	12315	6298	5915
65	10372	5026	4885
75	7707	4015	4061
85	3550	3250	3410

Mounting Details





A:	End Cap
B:	Suspension-mount with v-hook
C:	Surface Mount
D:	T-Bar Clip Mounting hole
E:	Wiring Knockout

Accessories (Ordered and Shipped Separately)

Mounting	
5011003-6	V-hook and Aircraft Cable Suspension Kit - 6'
5011003-10	V-hook and Aircraft Cable Suspension Kit - 10'

2917 Vail Ave.
Commerce Ca 90040

www.getdeco.com
info@getdeco.com
t: (800) 613-DECO
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DECO® | LIGHTING

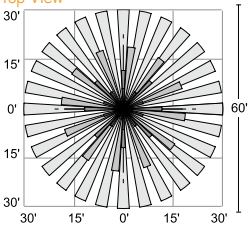
DACH-LED Round Architectural LED Channel

Digitize *your light.*®

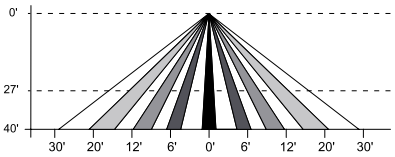
360° Fixture PIR Sensor

- Provides multi-level control based on motion and/or daylight contribution.
- Controls 0-10V VDC dimming LED drivers (or dimming ballasts); can also be used with non-dimming drivers.
- 40' range detector sensitivity.
- All control parameters are adjustable by using the RC-100 remote (sold separately)

Top View



Side View



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DECO® | LIGHTING

TYPE OL1

D-Series Size 0
Legacy LED Area Luminaire

Buy American

Catalog Number

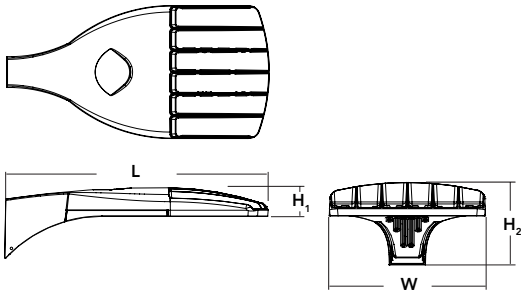
Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

EPA:	0.95 ft² (.09 m²)
Length:	26" (66.0 cm)
Width:	13" (33.0 cm)
Height$_1$:	3" (7.62 cm)
Height$_2$:	7" (17.8 cm)
Weight (max):	16 lbs (7.25 kg)



Introduction

The modern styling of the D-Series is striking yet unobtrusive - making a bold, progressive statement even as it blends seamlessly with its environment. The D-Series distills the benefits of the latest in LED technology into a high performance, high efficacy, long-life luminaire.

The outstanding photometric performance results in sites with excellent uniformity, greater pole spacing and lower power density. It is ideal for replacing up to 400W metal halide with typical energy savings of 70% and expected service life of over 100,000 hours.

OL1= M.H.= 14'-0"

ELECTRICAL CONTRACTOR TO DETERMINE MOUNTING REQUIREMENTS AND ACCESSORIES

Ordering Information

EXAMPLE: DSX0 LED P6 40K T3M MVOLT SPA NLTAIR2 PIRHN DDBXD G1

DSX0 LED

Series	LEDs	Color temperature	Distribution	Voltage	Mounting
DSX0 LED	**Forward optics** P1 P5 P2 P6 P3 P7[1] P4[1] **Rotated optics** P10[2] P12[2] P11[2] P13[1,2]	30K 3000 K 40K 4000 K 50K 5000 K	T1S Type I short (Automotive) T2S Type II short T2M Type II medium T3S Type III short T3M Type III medium T4M Type IV medium TFTM Forward throw medium T5VS Type V very short[3] T5S Type V short[3] T5M Type V medium[3] T5W Type V wide[3] BLC Backlight control[4] LCCO Left corner cutoff[4] RCCO Right corner cutoff[4]	MVOLT (120V-277V)[5,6] XVOLT (277V-480V)[7,8,9] 120[6] 208[6] 240[6] 277[6] 347[6] 480[6]	**Shipped included** SPA Square pole mounting RPA Round pole mounting[10] WBA Wall bracket[3] SPUMBA Square pole universal mounting adaptor[11] RPUMBA Round pole universal mounting adaptor[11] **Shipped separately** KMA8 DDBXD U Mast arm mounting bracket adaptor (specify finish)[12]

Control options		Other options	Finish *(required)*	Generation *(required)*
Shipped installed NLTAIR2 nLight AIR generation 2 enabled[13,14] PIRHN Network, high/low motion/ambient sensor[15] PER NEMA twist-lock receptacle only (control ordered separate)[16] PER5 Five-pin receptacle only (control ordered separate)[16,17] PER7 Seven-pin receptacle only (leads exit fixture) (control ordered separate)[16,17] DMG 0-10V dimming extend out back of housing for external control (control ordered separate)[18]	PIR High/low, motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 5fc[19,20] PIRH High/low, motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 5fc[19,20] PIR1FC3V High/low, motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 1fc[19,20] PIRH1FC3V High/low, motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 1fc[19,20] FAO Field adjustable output[19,21]	**Shipped installed** HS House-side shield[22] SF Single fuse (120, 277, 347V)[6] DF Double fuse (208, 240, 480V)[6] L90 Left rotated optics[2] R90 Right rotated optics[2] DDL Diffused drop lens[22] HA 50°C ambient operations[1] BAA Buy America(n) Act Compliant **Shipped separately** BS Bird spikes[23] EGS External glare shield	DDBXD Dark bronze DBLXD Black DNAXD Natural aluminum DWHXD White DDBTXD Textured dark bronze DBLBXD Textured black DNATXD Textured natural aluminum DWHGXD Textured white	G1 Generation 1

PROVIDE SHIELD WHERE INDICATED

One Lithonia Way • Conyers, Georgia 30012 • Phone: 1-800-705-SERV (7378) • www.lithonia.com

Ordering Information

Accessories

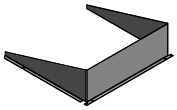
Ordered and shipped separately.

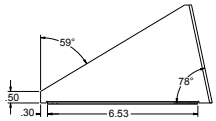
DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) [24]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V) [24]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V) [24]
DSHORT SBK U	Shorting cap [24]
DSX0HS 20C U G1	House-side shield for P1,P2,P3 and P4 [22]
DSX0HS 30C U G1	House-side shield for P10,P11,P12 and P13 [22]
DSX0HS 40C U G1	House-side shield for P5,P6 and P7 [22]
DSX0DDL U G1	Diffused drop lens (polycarbonate) [22]
PUMBA DDBXD U G1*	Square and round pole universal mounting bracket adaptor (specify finish) [25]
KMA8 DDBXD U	Mast arm mounting bracket adaptor (specify finish) [12]
DSX0EGS (FINISH) U G1	External glare shield

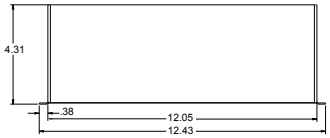
For more control options, visit DTL and ROAM online. Link to nLight Air 2

NOTES
1 HA not available with P4, P7, and P13.
2 P10, P11, P12 and P13 and rotated options (L90 or R90) only available together.
3 Any Type 5 distribution with photocell, is not available with WBA.
4 Not available with HS or DDL.
5 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
6 Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V. XVOLT not available with fusing (SF or DF).
7 XVOLT only suitable for use with P4, P7 and P13.
8 XVOLT operates with any voltage between 277V and 480V.
9 XVOLT not available with fusing (SF or DF) and not available with PIR, PIRH, PIR1FC3V, PIRH1FC3V.
10 Suitable for mounting to round poles between 3.5" and 12" diameter.
11 Universal mounting brackets intended for retrofit on existing pre-drilled poles only. 1.5 G vibration load rating per ANCI C136.31. Only usable when pole's drill pattern is NOT Lithonia template #8.
12 Must order fixture with SPA mounting. KMA8 must be ordered as a separate accessory; see Accessories information. For use with 2-3/8" diameter mast arm (not included).
13 Must be ordered with PIRHN.
14 Sensor cover available only in dark bronze, black, white and natural aluminum colors.
15 Must be ordered with NLTAIR2. For more information on nLight Air 2 visit this link.
16 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Shorting Cap included.
17 If ROAM® node required, it must be ordered and shipped as a separate line item from Acuity Brands Controls. Shorting Cap included.
18 DMG not available with PIRHN, PER5, PER7, PIR, PIRH, PIR1FC3V or PIRH1FC3V, FAO.
19 Reference Controls Options table on page 4.
20 Reference Motion Sensor Default Table on page 4 to see functionality.
21 Not available with other dimming controls options.
22 Not available with BLC, LCCO and RCCO distribution.
23 Must be ordered with fixture for factory pre-drilling.
24 Requires luminaire to be specified with PER, PER5 or PER7 option. See Controls Table on page 4.
25 For retrofit use only. Only usable when pole's drill pattern is NOT Lithonia template #8.

EGS – External Glare Shield

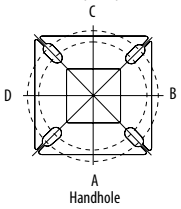


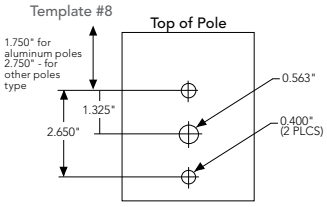




Drilling

HANDHOLE ORIENTATION
(from top of pole)





Tenon Mounting Slipfitter

Tenon O.D.	Mounting	Single Unit	2 @ 180	2 @ 90	3 @ 90	3 @120	4 @ 90
2-3/8"	RPA	AS3-5 190	AS3-5 280	AS3-5 290	AS3-5 390	AS3-5 320	AS3-5 490
2-7/8"	RPA	AST25-190	AST25-280	AST25-290	AST25-390	AST25-320	AST25-490
4"	RPA	AST35-190	AST35-280	AST35-290	AST35-390	AST35-320	AST35-490

Mounting Option	Drilling Template	Single	2 @ 180	2 @ 90	3 @ 90	3 @ 120	4 @ 90
Head Location		Side B	Side B & D	Side B & C	Side B, C & D	Round Pole Only	Side A, B, C & D
Drill Nomenclature	#8	DM19AS	DM28AS	DM29AS	DM39AS	DM32AS	DM49AS
		Minimum Acceptable Outside Pole Dimension					
SPA	#8	2-7/8"	2-7/8"	3.5"	3.5"		3.5"
RPA	#8	2-7/8"	2-7/8"	3.5"	3.5"	3"	3.5"
SPUMBA	#5	2-7/8"	3"	4"	4"		4"
RPUMBA	#5	2-7/8"	3.5"	5"	5"	3.5"	5"

DSX0 Area Luminaire - EPA

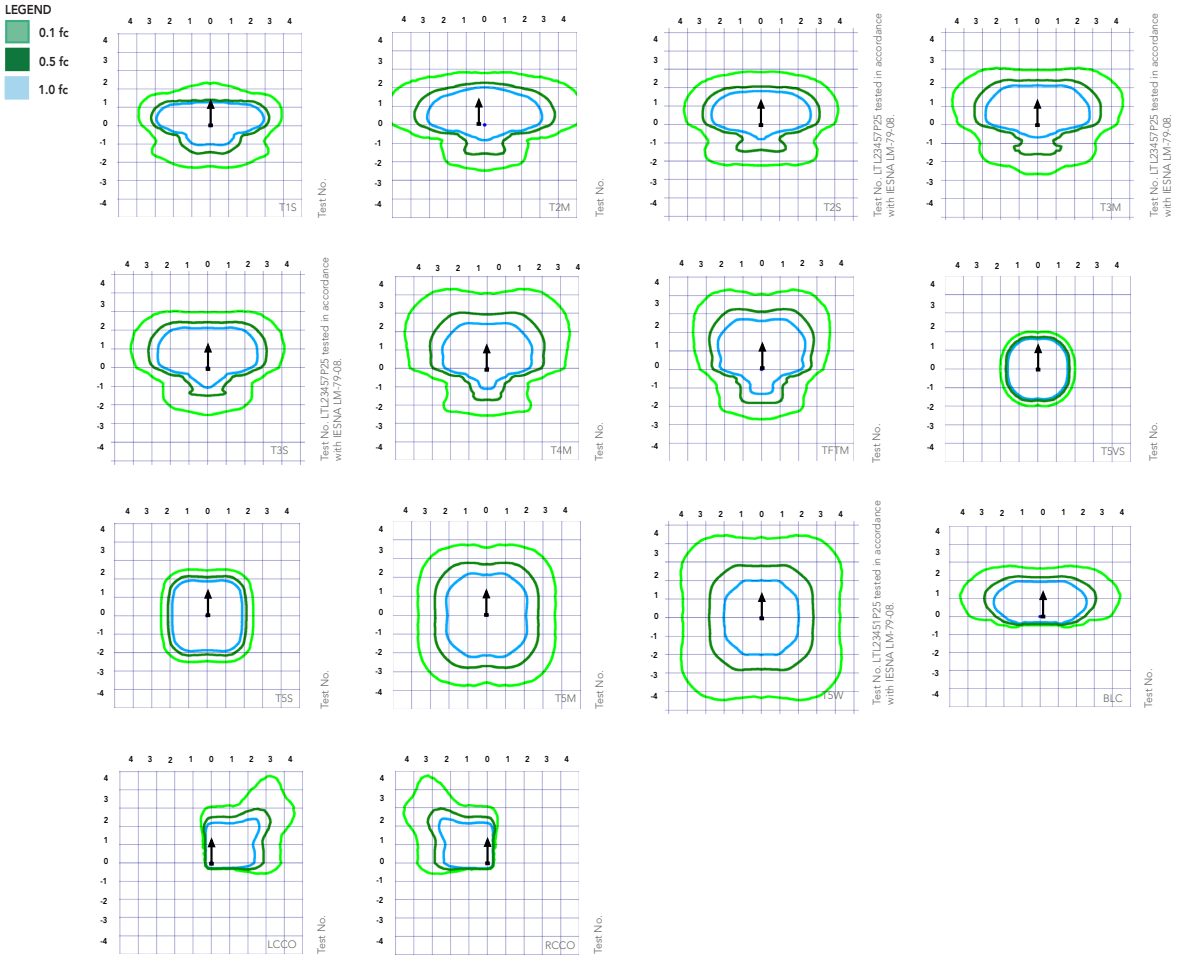
*Includes luminaire and integral mounting arm. Other tenons, arms, brackets or other accessories are not included in this EPA data.

Fixture Quantity & Mounting Configuration	Single DM19	2 @ 180 DM28	2 @ 90 DM29	3 @ 90 DM39	3 @ 120 DM32	4 @ 90 DM49
Mounting Type						
DSX0 LED	0.950	1.900	1.830	2.850	2.850	3.544

Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Area Size 0 homepage.

Isofootcandle plots for the DSX0 LED P6 40K G1. Distances are in units of mounting height (20').



Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.04
5°C	41°F	1.04
10°C	50°F	1.03
15°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°F**	**1.00**
30°C	86°F	0.99
35°C	95°F	0.98
40°C	104°F	0.97

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the platforms noted in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	Lumen Maintenance Factor
25,000	0.96
50,000	0.92
100,000	0.85

Motion Sensor Default Settings						
Option	Dimmed State	High Level (when triggered)	Phototcell Operation	Dwell Time	Ramp-up Time	Ramp-down Time
PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	5 min	3 sec	5 min
*PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	5 min	3 sec	5 min
*for use when motion sensor is used as dusk to dawn control.						

Electrical Load

	Performance Package	LED Count	Drive Current	Wattage	Current (A) 120	208	240	277	347	480
Forward Optics (Non-Rotated)	P1	20	530	38	0.32	0.18	0.15	0.15	0.10	0.08
	P2	20	700	49	0.41	0.23	0.20	0.19	0.14	0.11
	P3	20	1050	71	0.60	0.37	0.32	0.27	0.21	0.15
	P4	20	1400	92	0.77	0.45	0.39	0.35	0.28	0.20
	P5	40	700	89	0.74	0.43	0.38	0.34	0.26	0.20
	P6	40	1050	134	1.13	0.65	0.55	0.48	0.39	0.29
	P7	40	1300	166	1.38	0.80	0.69	0.60	0.50	0.37
Rotated Optics (Requires L90 or R90)	P10	30	530	53	0.45	0.26	0.23	0.21	0.16	0.12
	P11	30	700	72	0.60	0.35	0.30	0.27	0.20	0.16
	P12	30	1050	104	0.88	0.50	0.44	0.39	0.31	0.23
	P13	30	1300	128	1.08	0.62	0.54	0.48	0.37	0.27

Controls Options

Nomenclature	Description	Functionality	Primary control device	Notes
FAO	Field adjustable output device installed inside the luminaire; wired to the driver dimming leads.	Allows the luminaire to be manually dimmed, effectively trimming the light output.	FAO device	Cannot be used with other controls options that need the 0-10V leads
DS	Drivers wired independently for 50/50 luminaire operation	The luminaire is wired to two separate circuits, allowing for 50/50 operation.	Independently wired drivers	Requires two separately switched circuits. Consider nLight AIR as a more cost effective alternative.
PER5 or PER7	Twist-lock photocell receptacle	Compatible with standard twist-lock photocells for dusk to dawn operation, or advanced control nodes that provide 0-10V dimming signals.	Twist-lock photocells such as DLL Elite or advanced control nodes such as ROAM.	Pins 4 & 5 to dimming leads on driver, Pins 6 & 7 are capped inside luminaire
PIR or PIRH	Motion sensors with integral photocell. PIR for 8-15' mounting; PIRH for 15-30' mounting	Luminaires dim when no occupancy is detected.	Acuity Controls SBGR	Also available with PIRH1FC3V when the sensor photocell is used for dusk-to-dawn operation.
NLTAIR2 PIRHN	nLight AIR enabled luminaire for motion sensing, photocell and wireless communication.	Motion and ambient light sensing with group response. Scheduled dimming with motion sensor over-ride when wirelessly connected to the nLight Eclypse.	nLight Air rSDGR	nLight AIR sensors can be programmed and commissioned from the ground using the CIAIRity Pro app.

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

Forward Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P1	20	530	38W	T1S	4,369	1	0	1	115	4,706	1	0	1	124	4,766	1	0	1	125
				T2S	4,387	1	0	1	115	4,726	1	0	1	124	4,785	1	0	1	126
				T2M	4,364	1	0	1	115	4,701	1	0	1	124	4,761	1	0	1	125
				T3S	4,376	1	0	1	115	4,714	1	0	1	124	4,774	1	0	1	126
				T3M	4,248	1	0	1	112	4,577	1	0	1	120	4,634	1	0	1	122
				T4M	4,281	1	0	1	113	4,612	1	0	2	121	4,670	1	0	2	123
				TFTM	4,373	1	0	1	115	4,711	1	0	2	124	4,771	1	0	2	126
				T5VS	4,548	2	0	0	120	4,900	2	0	0	129	4,962	2	0	0	131
				T5S	4,552	2	0	0	120	4,904	2	0	0	129	4,966	2	0	0	131
				T5M	4,541	3	0	1	120	4,891	3	0	1	129	4,953	3	0	1	130
				T5W	4,576	3	0	2	120	4,929	3	0	2	130	4,992	3	0	2	131
				BLC	3,586	1	0	1	94	3,863	1	0	1	102	3,912	1	0	1	103
				LCCO	2,668	1	0	1	70	2,874	1	0	2	76	2,911	1	0	2	77
				RCCO	2,668	1	0	1	70	2,874	1	0	2	76	2,911	1	0	2	77
P2	20	700	49W	T1S	5,570	1	0	1	114	6,001	1	0	1	122	6,077	2	0	2	124
				T2S	5,593	1	0	1	114	6,025	1	0	1	123	6,102	1	0	1	124
				T2M	5,564	1	0	2	114	5,994	1	0	2	122	6,070	2	0	2	125
				T3S	5,580	1	0	2	114	6,011	1	0	2	123	6,087	1	0	2	124
				T3M	5,417	1	0	2	111	5,835	1	0	2	119	5,909	2	0	2	121
				T4M	5,458	1	0	2	111	5,880	1	0	2	120	5,955	1	0	2	122
				TFTM	5,576	1	0	2	114	6,007	1	0	2	123	6,083	1	0	2	124
				T5VS	5,799	2	0	0	118	6,247	2	0	0	127	6,327	2	0	0	129
				T5S	5,804	2	0	0	118	6,252	2	0	0	128	6,332	2	0	1	129
				T5M	5,789	3	0	1	118	6,237	3	0	1	127	6,316	3	0	1	129
				T5W	5,834	3	0	2	119	6,285	3	0	2	128	6,364	3	0	2	130
				BLC	4,572	1	0	1	93	4,925	1	0	1	101	4,987	1	0	1	102
				LCCO	3,402	1	0	2	69	3,665	1	0	2	75	3,711	1	0	2	76
				RCCO	3,402	1	0	2	69	3,665	1	0	2	75	3,711	1	0	2	76
P3	20	1050	71W	T1S	7,833	2	0	2	110	8,438	2	0	2	119	8,545	2	0	2	120
				T2S	7,865	2	0	2	111	8,473	2	0	2	119	8,580	2	0	2	121
				T2M	7,825	2	0	2	110	8,429	2	0	2	119	8,536	2	0	2	120
				T3S	7,846	2	0	2	111	8,452	2	0	2	119	8,559	2	0	2	121
				T3M	7,617	2	0	2	107	8,205	2	0	2	116	8,309	2	0	2	117
				T4M	7,675	2	0	2	108	8,269	2	0	2	116	8,373	2	0	2	118
				TFTM	7,841	2	0	2	110	8,447	2	0	2	119	8,554	2	0	2	120
				T5VS	8,155	3	0	0	115	8,785	3	0	0	124	8,896	3	0	0	125
				T5S	8,162	3	0	1	115	8,792	3	0	1	124	8,904	3	0	1	125
				T5M	8,141	3	0	2	115	8,770	3	0	2	124	8,881	3	0	2	125
				T5W	8,204	3	0	2	116	8,838	4	0	2	124	8,950	4	0	2	126
				BLC	6,429	1	0	2	91	6,926	1	0	2	98	7,013	1	0	2	99
				LCCO	4,784	1	0	2	67	5,153	1	0	2	73	5,218	1	0	2	73
				RCCO	4,784	1	0	2	67	5,153	1	0	2	73	5,218	1	0	2	73
P4	20	1400	92W	T1S	9,791	2	0	2	106	10,547	2	0	2	115	10,681	2	0	2	116
				T2S	9,831	2	0	2	107	10,590	2	0	2	115	10,724	2	0	2	117
				T2M	9,780	2	0	2	106	10,536	2	0	2	115	10,669	2	0	2	116
				T3S	9,807	2	0	2	107	10,565	2	0	2	115	10,698	2	0	2	116
				T3M	9,521	2	0	2	103	10,256	2	0	2	111	10,386	2	0	2	113
				T4M	9,594	2	0	2	104	10,335	2	0	3	112	10,466	2	0	3	114
				TFTM	9,801	2	0	2	107	10,558	2	0	2	115	10,692	2	0	2	116
				T5VS	10,193	3	0	1	111	10,981	3	0	1	119	11,120	3	0	1	121
				T5S	10,201	3	0	1	111	10,990	3	0	1	119	11,129	3	0	1	121
				T5M	10,176	4	0	2	111	10,962	4	0	2	119	11,101	4	0	2	121
				T5W	10,254	4	0	3	111	11,047	4	0	3	120	11,186	4	0	3	122
				BLC	8,036	1	0	2	87	8,656	1	0	2	94	8,766	1	0	2	95
				LCCO	5,979	1	0	2	65	6,441	1	0	2	70	6,523	1	0	3	71
				RCCO	5,979	1	0	2	65	6,441	1	0	2	70	6,523	1	0	3	71

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

Forward Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P5	40	700	89W	T1S	10,831	2	0	2	122	11,668	2	0	2	131	11,816	2	0	2	133
				T2S	10,876	2	0	2	122	11,716	2	0	2	132	11,864	2	0	2	133
				T2M	10,820	2	0	2	122	11,656	2	0	2	131	11,803	2	0	2	133
				T3S	10,849	2	0	2	122	11,687	2	0	2	131	11,835	2	0	2	133
				T3M	10,532	2	0	2	118	11,346	2	0	2	127	11,490	2	0	2	129
				T4M	10,613	2	0	3	119	11,434	2	0	3	128	11,578	2	0	3	130
				TFTM	10,842	2	0	2	122	11,680	2	0	2	131	11,828	2	0	2	133
				T5VS	11,276	3	0	1	127	12,148	3	0	1	136	12,302	3	0	1	138
				T5S	11,286	3	0	1	127	12,158	3	0	1	137	12,312	3	0	1	138
				T5M	11,257	4	0	2	126	12,127	4	0	2	136	12,280	4	0	2	138
				T5W	11,344	4	0	3	127	12,221	4	0	3	137	12,375	4	0	3	139
				BLC	8,890	1	0	2	100	9,576	1	0	2	108	9,698	1	0	2	109
				LCCO	6,615	1	0	3	74	7,126	1	0	3	80	7,216	1	0	3	81
				RCCO	6,615	1	0	3	74	7,126	1	0	3	80	7,216	1	0	3	81
P6	40	1050	134W	T1S	14,805	3	0	3	110	15,949	3	0	3	119	16,151	3	0	3	121
				T2S	14,865	3	0	3	111	16,014	3	0	3	120	16,217	3	0	3	121
				T2M	14,789	3	0	3	110	15,932	3	0	3	119	16,134	3	0	3	120
				T3S	14,829	2	0	3	111	15,975	3	0	3	119	16,177	3	0	3	121
				T3M	14,396	3	0	3	107	15,509	3	0	3	116	15,705	3	0	3	117
				T4M	14,507	2	0	3	108	15,628	3	0	3	117	15,826	3	0	3	118
				TFTM	14,820	2	0	3	111	15,965	3	0	3	119	16,167	3	0	3	121
				T5VS	15,413	4	0	1	115	16,604	4	0	1	124	16,815	4	0	1	125
				T5S	15,426	3	0	1	115	16,618	4	0	1	124	16,828	4	0	1	126
				T5M	15,387	4	0	2	115	16,576	4	0	2	124	16,786	4	0	2	125
				T5W	15,506	4	0	3	116	16,704	4	0	3	125	16,915	4	0	3	126
				BLC	12,151	1	0	2	91	13,090	1	0	2	98	13,255	1	0	2	99
				LCCO	9,041	1	0	3	67	9,740	1	0	3	73	9,863	1	0	3	74
				RCCO	9,041	1	0	3	67	9,740	1	0	3	73	9,863	1	0	3	74
P7	40	1300	166W	T1S	17,023	3	0	3	103	18,338	3	0	3	110	18,570	3	0	3	112
				T2S	17,092	3	0	3	103	18,413	3	0	3	111	18,646	3	0	3	112
				T2M	17,005	3	0	3	102	18,319	3	0	3	110	18,551	3	0	3	112
				T3S	17,051	3	0	3	103	18,369	3	0	3	111	18,601	3	0	3	112
				T3M	16,553	3	0	3	100	17,832	3	0	3	107	18,058	3	0	3	109
				T4M	16,681	3	0	3	100	17,969	3	0	3	108	18,197	3	0	3	110
				TFTM	17,040	3	0	3	103	18,357	3	0	4	111	18,590	3	0	4	112
				T5VS	17,723	4	0	1	107	19,092	4	0	1	115	19,334	4	0	1	116
				T5S	17,737	4	0	2	107	19,108	4	0	2	115	19,349	4	0	2	117
				T5M	17,692	4	0	2	107	19,059	4	0	2	115	19,301	4	0	2	116
				T5W	17,829	5	0	3	107	19,207	5	0	3	116	19,450	5	0	3	117
				BLC	13,971	2	0	2	84	15,051	2	0	2	91	15,241	2	0	2	92
				LCCO	10,396	1	0	3	63	11,199	1	0	3	67	11,341	1	0	3	68
				RCCO	10,396	1	0	3	63	11,199	1	0	3	67	11,341	1	0	3	68

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

Rotated Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P10	30	530	53W	T1S	6,727	2	0	2	127	7,247	3	0	3	137	7,339	3	0	3	138
				T2S	6,809	3	0	3	128	7,336	3	0	3	138	7,428	3	0	3	140
				T2M	6,689	3	0	3	126	7,205	3	0	3	136	7,297	3	0	3	138
				T3S	6,805	3	0	3	128	7,331	3	0	3	138	7,424	3	0	3	140
				T3M	6,585	3	0	3	124	7,094	3	0	3	134	7,183	3	0	3	136
				T4M	6,677	3	0	3	126	7,193	3	0	3	136	7,284	3	0	3	137
				TFTM	6,850	3	0	3	129	7,379	3	0	3	139	7,472	3	0	3	141
				T5VS	6,898	3	0	0	130	7,431	3	0	0	140	7,525	3	0	0	142
				T5S	6,840	2	0	1	129	7,368	2	0	1	139	7,461	2	0	1	141
				T5M	6,838	3	0	1	129	7,366	3	0	2	139	7,460	3	0	2	141
				T5W	6,777	3	0	2	128	7,300	3	0	2	138	7,393	3	0	2	139
				BLC	5,626	2	0	2	106	6,060	2	0	2	114	6,137	2	0	2	116
				LCCO	4,018	1	0	2	76	4,328	1	0	2	82	4,383	1	0	2	83
				RCCO	4,013	3	0	3	76	4,323	3	0	3	82	4,377	3	0	3	83
P11	30	700	72W	T1S	8,594	3	0	3	119	9,258	3	0	3	129	9,376	3	0	3	130
				T2S	8,699	3	0	3	121	9,371	3	0	3	130	9,490	3	0	3	132
				T2M	8,545	3	0	3	119	9,205	3	0	3	128	9,322	3	0	3	129
				T3S	8,694	3	0	3	121	9,366	3	0	3	130	9,484	3	0	3	132
				T3M	8,412	3	0	3	117	9,062	3	0	3	126	9,177	3	0	3	127
				T4M	8,530	3	0	3	118	9,189	3	0	3	128	9,305	3	0	3	129
				TFTM	8,750	3	0	3	122	9,427	3	0	3	131	9,546	3	0	3	133
				T5VS	8,812	3	0	0	122	9,493	3	0	0	132	9,613	3	0	0	134
				T5S	8,738	3	0	1	121	9,413	3	0	1	131	9,532	3	0	1	132
				T5M	8,736	3	0	2	121	9,411	3	0	2	131	9,530	3	0	2	132
				T5W	8,657	4	0	2	120	9,326	4	0	2	130	9,444	4	0	2	131
				BLC	7,187	3	0	3	100	7,742	3	0	3	108	7,840	3	0	3	109
				LCCO	5,133	1	0	2	71	5,529	1	0	2	77	5,599	1	0	2	78
				RCCO	5,126	3	0	3	71	5,522	3	0	3	77	5,592	3	0	3	78
P12	30	1050	104W	T1S	12,149	3	0	3	117	13,088	3	0	3	126	13,253	3	0	3	127
				T2S	12,297	3	0	3	118	13,247	3	0	3	127	13,415	3	0	3	129
				T2M	12,079	4	0	4	116	13,012	4	0	4	125	13,177	4	0	4	127
				T3S	12,290	3	0	3	118	13,239	4	0	4	127	13,407	4	0	4	129
				T3M	11,891	4	0	4	114	12,810	4	0	4	123	12,972	4	0	4	125
				T4M	12,058	4	0	4	116	12,990	4	0	4	125	13,154	4	0	4	126
				TFTM	12,369	4	0	4	119	13,325	4	0	4	128	13,494	4	0	4	130
				T5VS	12,456	3	0	1	120	13,419	3	0	1	129	13,589	4	0	1	131
				T5S	12,351	3	0	1	119	13,306	3	0	1	128	13,474	3	0	1	130
				T5M	12,349	4	0	2	119	13,303	4	0	2	128	13,471	4	0	2	130
				T5W	12,238	4	0	3	118	13,183	4	0	3	127	13,350	4	0	3	128
				BLC	10,159	3	0	3	98	10,944	3	0	3	105	11,083	3	0	3	107
				LCCO	7,256	1	0	3	70	7,816	1	0	3	75	7,915	1	0	3	76
				RCCO	7,246	3	0	3	70	7,806	4	0	4	75	7,905	4	0	4	76
P13	30	1300	128W	T1S	14,438	3	0	3	113	15,554	3	0	3	122	15,751	3	0	3	123
				T2S	14,614	3	0	3	114	15,744	4	0	4	123	15,943	4	0	4	125
				T2M	14,355	4	0	4	112	15,465	4	0	4	121	15,660	4	0	4	122
				T3S	14,606	4	0	4	114	15,735	4	0	4	123	15,934	4	0	4	124
				T3M	14,132	4	0	4	110	15,224	4	0	4	119	15,417	4	0	4	120
				T4M	14,330	4	0	4	112	15,438	4	0	4	121	15,633	4	0	4	122
				TFTM	14,701	4	0	4	115	15,836	4	0	4	124	16,037	4	0	4	125
				T5VS	14,804	4	0	1	116	15,948	4	0	1	125	16,150	4	0	1	126
				T5S	14,679	3	0	1	115	15,814	3	0	1	124	16,014	3	0	1	125
				T5M	14,676	4	0	2	115	15,810	4	0	2	124	16,010	4	0	2	125
				T5W	14,544	4	0	3	114	15,668	4	0	3	122	15,866	4	0	3	124
				BLC	7919	3	0	3	62	8531	3	0	3	67	8639	3	0	3	67
				LCCO	5145	1	0	2	40	5543	1	0	2	43	5613	1	0	2	44
				RCCO	5139	3	0	3	40	5536	3	0	3	43	5606	3	0	3	44

FEATURES & SPECIFICATIONS

INTENDED USE
The sleek design of the D-Series Size 0 reflects the embedded high performance LED technology. It is ideal for many commercial and municipal applications, such as parking lots, plazas, campuses, and pedestrian areas.

CONSTRUCTION
Single-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance and future light engine upgrades. The LED driver is mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65). Low EPA (0.95 ft^2) for optimized pole wind loading.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in both textured and non-textured finishes.

OPTICS
Precision-molded proprietary acrylic lenses are engineered for superior area lighting distribution, uniformity, and pole spacing. Light engines are available in 3000 K, 4000 K or 5000 K (70 CRI) configurations. The D-Series Size 0 has zero uplight and qualifies as a Nighttime Friendly™ product, meaning it is consistent with the LEED® and Green Globes™ criteria for eliminating wasteful uplight.

ELECTRICAL
Light engine(s) configurations consist of high-efficacy LEDs mounted to metal-core circuit boards to maximize heat dissipation and promote long life (up to L85/100,000 hours at 25°C). Class 1 electronic drivers are designed to have a power factor >90%, THD <20%, and an expected life of 100,000 hours with <1% failure rate. Easily serviceable 10kV surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

STANDARD CONTROLS
The DSX0 LED area luminaire has a number of control options. DSX Size 0, comes standard with 0-10V dimming driver. Dusk to dawn controls can be utilized via optional NEMA twist-lock photocell receptacles. Integrated motion sensors with on-board photocells feature field-adjustable programing and are suitable for mounting heights up to 30 feet.

nLIGHT AIR CONTROLS
The DSX0 LED area luminaire is also available with nLight® AIR for the ultimate in wireless control. This powerful controls platform provides out-of-the-box basic motion sensing and photocontrol functionality and is suitable for mounting heights up to 40 feet. Once commissioned using a smartphone and the easy-to-use CLAIRITY app, nLight AIR equipped luminaries can be grouped, resulting in motion sensor and photocell group response without the need for additional equipment. Scheduled dimming with motion sensor over-ride can be achieved when used with the nLight Eclypse. Additional information about nLight Air can be found here.

INSTALLATION
Included mounting block and integral arm facilitate quick and easy installation. Stainless steel bolts fasten the mounting block securely to poles and walls, enabling the D-Series Size 0 to withstand up to a 3.0 G vibration load rating per ANSI C136.31. The D-Series Size 0 utilizes the AERIS™ series pole drilling pattern (template #8). Optional terminal block and NEMA photocontrol receptacle are also available.

LISTINGS
UL listed to meet U.S. and Canadian standards. UL Listed for wet locations. Light engines are IP66 rated; luminaire is IP65 rated. Rated for -40°C to 50°C ambient with HA option. U.S. Patent No. D672,492 S. International patent pending.

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.

International Dark-Sky Association (IDA) Fixture Seal of Approval (FSA) is available for all products on this page utilizing 3000K color temperature only.

BUY AMERICAN
Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. 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.

LITHONIA LIGHTING®

Catalog Number	TYPICAL POLE QL1 & QL2 - HEIGHT AS INDICATED ON PLAN
Notes	PROVIDE SPECIFIED MANUFACTURER OR ENGINEER-APPROVED EQUAL.
Type	

Anchor Base Poles

SSA

SQUARE STRAIGHT ALUMINUM

FEATURES & SPECIFICATIONS

INTENDED USE — **These specifications are for USA standards only.** Square Straight Aluminum is a general purpose light pole for up to 35-foot mounting heights. This pole provides a lighter and naturally corrosion-resistant option for mounting area light fixtures and floodlights.

CONSTRUCTION —

Pole Shaft: The pole shaft is of uniform wall thickness and is made of extruded 6000 series aluminum alloy tubing that is heat treated to a T6 temper to provide maximum strength. The shaft is uniformly square in cross-section with flat sides, small corner radii and excellent torsional qualities. Available shaft widths are 4", 5", 6" and 6.75".

Pole Top: Options include tenon top, drilled for side mount fixture, tenon with drilling (includes extra handhole) and open top. A removable cast aluminum top cap with set screws is provided for all poles that will receive drilling patterns for side-mount luminaire arm assemblies or when ordered with open top (PT) option. The top cap resists intrusion of moisture and environmental contaminants.

Handhole: A handhole opening with grounding provision is provided near the base. Standard positioning varies with shaft width as follows: 4" shaft, handhole at 12"; 5" shaft, handhole at 14"; 6" and 6.75" shaft, handhole at 18". Positioning the handhole lower than standard may not be possible and requires engineering review; consult Tech Support-Outdoor for further information. Standard and extra handholes come with cover and attachment hardware. The handhole for a pole specified with a 4" or 5" shaft width has a nominal dimension of 2" x 4"; the handhole for a pole specified with a 6" or 6.75" width has a nominal dimension of 2.63" x 5". Standard and extra handholes come with cover and attachment hardware.

Bolt Caps/Base Cover: Pole base plate utilizes cast aluminum A365 nut cover discs to cover anchor bolt and nut assembly. 2 piece, spun aluminum base cover available as an option.

Anchor Base/Bolts: Anchor base is cast from A356 alloy aluminum. Anchor bolts are manufactured to ASTM F1554 Standards Grade 55, (55 KSI minimum yield strength and tensile strength of 75-95 KSI). Upper portion of anchor bolt is galvanized per ASTM A-153; bolts have an "L" bend on bottom end and are galvanized a minimum of 12" on the threaded end.

HARDWARE — All structural and non-structural fasteners are stainless-steel.

FINISH — Extra durable painted finish is coated with TGIC (Triglycidyl Isocyanurate) Polyester powder that meets 5A and 5B classifications of ASTM D3359. Standard powder-coat finishes include Dark Bronze, White, Black, and Natural Aluminum colors. Other finishes include Brushed Aluminum, and Anodized Dark Bronze, Anodized Natural Aluminum and Anodized Black. Architectural Colors and Special Finishes are available by quote and include, but are not limited to RAL Colors, Custom Colors and Extended Warranty Finishes.

GROUNDING: Grounding provision is located in handhole near the base. Grounding hardware is not included (provided by others).

INSTALLATION — **Do not** erect poles without having fixtures installed. Factory-supplied templates must be used when setting anchor bolts. Lithonia Lighting will not accept claim for incorrect anchorage placement due to failure to use Lithonia Lighting factory templates. If poles are stored outside, all protective wrapping must be removed immediately upon delivery to prevent finish damage. Lithonia Lighting is not responsible for the foundation design.

WARRANTY — 1-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.
Specifications subject to change without notice.

SSA Square Straight Aluminum Poles

COORDINATE FINISH WITH ARCHITECT.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: SSA 20 4C DM19 BA

SSA					
Series	**Nominal fixture mounting height**	**Nominal shaft base size/wall thickness[1]**	**Mounting[2]**	**Options**	**Finish[11]**
SSA	8'-35' (for 1/2 ft increments, add -6 to the pole height. Ex: 20-6 equals 20ft 6in.) (See technical information table for complete ordering information.)	4C 4" (0.125") 4G 4" (0.188") 5G 5" (0.188") 6G 6" (0.188") 6J 6" (0.250") 7J 7" (0.250") (See technical information table for complete ordering information.)	Tenon mounting PT Open top T20 2-3/8" O.D. (2" NPS) T25 2-7/8" O.D. (2-1/2" NPS) T30 3-1/2" O.D. (3" NPS)[3] T35 4" O.D. (3-1/2" NPS)[3] KAC/KAD/KSE/KSF/KVR/KVF Drill mounting[4] DM19 1 at 90° DM28 2 at 180° DM28PL 2 at 180° with one side plugged DM29 2 at 90° DM39 3 at 90° DM49 4 at 90° CSX/DSX/RSX/AERIS™/OMERO™/HLA/KAX Drill mounting[4] DM19AS 1 at 90° DM28AS 2 at 180° DM29AS 2 at 90° DM39AS 3 at 90° DM49AS 4 at 90° RAD drill mounting[4] DM19RAD 1 at 90° DM28RAD 2 at 180° DM29RAD 2 at 90° DM39RAD 3 at 90° DM49RAD 4 at 90° ESX Drill mounting[3] DM19ESX 1 at 90° DM28ESX 2 at 180° DM29ESX 2 at 90° DM39ESX 3 at 90° DM49ESX 4 at 90° AERIS™ Suspend drill mounting[4,5] DM19AST_ 1 at 90° DM28AST_ 2 at 180° DM29AST_ 2 at 90° DM39AST_ 3 at 90° DM49AST_ 4 at 90° OMERO™ Suspend drill mounting[4,5] DM19MRT_ 1 at 90° DM28MRT_ 2 at 180° DM29MRT_ 2 at 90° DM39MRT_ 3 at 90° DM49MRT_ 4 at 90°	L/AB Less anchor bolts (Include when anchor bolts are not needed) VD Vibration damper TP Tamper proof HAxy Horizontal arm bracket (1 fixture)[6,7] FDLxy Festoon outlet less electrical[6,8] CPL12/xy 1/2" I.D. coupling[6] CPL34/xy 3/4" I.D. coupling[6] CPL1/xy 1" I.D. coupling[6] NPL12/xy 1/2" O.D. threaded nipple[6] NPL34/xy 3/4" O.D. threaded nipple[6] NPL1/xy 1" O.D. threaded nipple[6] EHHxy Extra handhole[6,9] BAA Buy America(n) Act Compliant[10] UL UL listed with label (Includes NEC compliant cover) NEC NEC 410.30 compliant gasketed handhole (Not UL Labeled) FBC Full base cover (spun aluminum)	Super durable paint colors DDBXD Dark bronze DBLXD Black DNAXD Natural aluminum DWHXD White DDBTXD Textured dark bronze DBLBXD Textured black DNATXD Textured natural aluminum DWHGXD Textured white Brushed finish BA Brushed aluminum Class 1 architectural anodized ABL Black ADB Dark bronze ANA Natural Architectural colors (powder finish) Duranodic Anodize, Paint over Duranodic Anodize, RAL Colors, Custom Colors and Extended Warranty Finishes available.

NOTES:

1. Wall thickness will be signified with a "C", "G" or a "J" in nomenclature. "C" - 0.125 | "G" - 0.188 | "J" - 0.250.
2. PT open top poles include top cap. When ordering tenon mounting and drill mounting for the same pole, follow this example: DM28/T20. The combination includes a required extra handhole.
3. 3-1/2" and 4" O.D. tenons available on 5" and 6" shafts only.
4. Refer to the fixture spec sheet for the correct drilling template pattern and orientation compatibility.
5. Insert "1" or "2" to designate fixture size; e.g. DM19AST2.
6. Specify location and orientation when ordering option.
   For "x": Specify the height in feet above base of pole.
   Example: 5ft = 5 and 20ft, 3in = 20-3
   For "y": Specify orientation from handhole (A,B,C,D) Refer to the Handhole Orientation diagram below.
   Example: 1/2" coupling at 5'8", orientation C = CPL12/5-8C
7. Horizontal arm is 18" x 2-3/8" O.D. tenon standard, with radius curve providing 12" rise and 2-3/8" O.D. If ordering two horizontal arm at the same height, specify with HAxyy. Example: HA20BD
8. FDL does not come with additional covering. Festoons must be a minimum of 3ft (36in) from the base in any orientation. Distance between any festoon and/or handhole must be at least 1ft and 6in (18in) apart in any orientation.
9. Combination of tenon-top and drill mount includes extra handhole. Extra Handholes must be a minimum of 3ft (36in) from the base in any orientation. Distance between any festoon and/or handhole must be at least 1ft and 6in (18in) apart in any orientation.
10. Use when mill certifications are required. Some configurations may be excluded, consult factory.
11. Finish must be specified. Additional colors available; see Architectural Colors brochure linked here (Form No. 794.3).

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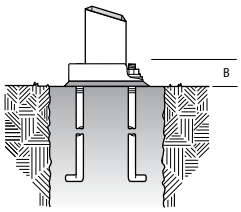
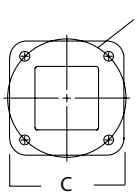
SSA Square Straight Aluminum Poles

TECHNICAL INFORMATION — EPA (FT²) WITH 1.3 GUST									
Catalog number	**Nominal mount ht. (ft) ***	**Pole shaft size (in x ft)**	**Wall thick (in)**	**80 mph**	**90 mph**	**100 mph**	**Max. weight (lbs)**	**Bolt size (in. x in. x in.)**	**Approximate ship (lbs.)**
SSA 8 4C	8	4.0 x 8.0	0.125	16.5	12.6	9.9	300	3/4 x 18 x 3	32
SSA 10 4C	10	4.0 x 10.0	0.125	11.5	8.6	6.5	230	3/4 x 18 x 3	37
SSA 12 4C	12	4.0 x 12.0	0.125	12.4	9.2	6.9	160	3/4 x 18 x 3	40
SSA 14 4C	14	4.0 x 14.0	0.125	9.3	6.7	4.8	120	3/4 x 18 x 3	50
SSA 15 4C	15	4.0 x 15.0	0.125	8	5.6	3.9	100	3/4 x 18 x 3	52
SSA 16 4C	16	4.0 x 16.0	0.125	6.9	4.7	3.1	90	3/4 x 18 x 3	54
SSA 16 4G	16	4.0 x 16.0	0.188	11.8	8.5	6.2	130	3/4 x 30 x 3	74
SSA 16 5G	16	5.0 x 16.0	0.188	15	11.1	7.5	280	3/4 x 30 x 3	83
SSA 18 4C	18	4.0 x 18.0	0.125	4.9	3	1.7	70	3/4 x 18 x 3	57
SSA 18 4G	18	4.0 x 18.0	0.188	9.2	6.4	4.4	100	3/4 x 30 x 3	80
SSA 18 5G	18	5.0 x 18.0	0.188	16.8	12.2	8.9	230	3/4 x 30 x 3	91
SSA 20 4C	20	4.0 x 20.0	0.125	3.3	1.7	0.5	40	3/4 x 18 x 3	62
SSA 20 4G	20	4.0 x 20.0	0.188	7	4.6	2.9	80	3/4 x 30 x 3	85
SSA 20 5G	20	5.0 x 20.0	0.188	13.6	9.5	6.6	180	3/4 x 30 x 3	107
SSA 20 6G	20	6.0 x 20.0	0.188	22	15.9	11.6	230	1 x 36 x 4	155
SSA 20 6J	20	6.0 x 20.0	0.25	30.4	22.6	17	300	1 x 36 x 4	202
SSA 25 5G	25	5.0 x 25.0	0.188	7.2	4.2	2	110	3/4 x 30 x 3	130
SSA 25 6G	25	6.0 x 25.0	0.188	13.2	8.6	5.4	180	1 x 36 x 4	180
SSA 25 6J	25	6.0 x 25.0	0.25	19.7	13.8	9.5	250	1 x 36 x 4	224
SSA 30 6G	30	6.0 x 30.0	0.188	7	3.4	0.8	130	1 x 36 x 4	210
SSA 30 6J	30	6.0 x 30.0	0.25	12.2	7.5	4.1	170	1 x 36 x 4	258
SSA 32 6J	32	6.0 x 32.0	0.25	9.7	5.4	2.3	160	1 x 36 x 4	272
SSA 35 6J	35	6.0 x 35.0	0.25	6.4	2.6	--	200	1 x 36 x 4	294
SSA 35 7J	35	6.75 x 35.0	0.25	7.6	3.1	--	150	1 x 36 x 4	290

NOTE: *EPA values are based ASCE 7-93 wind map. For 1/2 ft increments, add -6 to the pole height. Ex: 20-6 equals 20ft 6in.

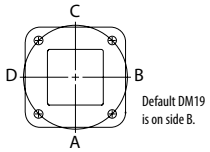
BASE DETAIL





POLE DATA						
Shaft base size	**Bolt circle A**	**Bolt projection B**	**Base square C**	**Bolt size**	**Template description**	**Anchor bolt description**
4"C	8.5" – 9.625"	3.125"	9.938"	3/4" x 18" x 3"	ABTEMPLATE PJ50045	AB18-0
4"G	8.5" – 9.625"	3.125"	9.938"	3/4" x 30" x 3"	ABTEMPLATE PJ50045	AB30-0
5"	10.5" – 11.5"	3.25"	11.563"	3/4" x 30" x 3"	ABTEMPLATE PJ50046	AB30-0
6"	12"–13"	4"	12.25"	1" x 36" x 4"	ABTEMPLATE PJ50044	AB36-0
7"	14.625"	4.125"	15"	1" x 36" x 4"	ABTEMPLATE PJ50130	AB36-0

HANDHOLE ORIENTATION



Default DM19 is on side B.

Handhole

IMPORTANT INSTALLATION NOTES:

- **Do not** erect poles without having fixtures installed.
- Factory-supplied templates must be used when setting anchor bolts. Lithonia Lighting will not accept claim for incorrect anchorage placement due to failure to use factory template.
- If poles are stored outside, all protective wrapping must be removed immediately upon delivery to prevent finish damage.
- Lithonia Lighting is not responsible for the foundation design.

TYPE OL2

D-Series Size 0
Legacy LED Area Luminaire

Buy American

Catalog Number

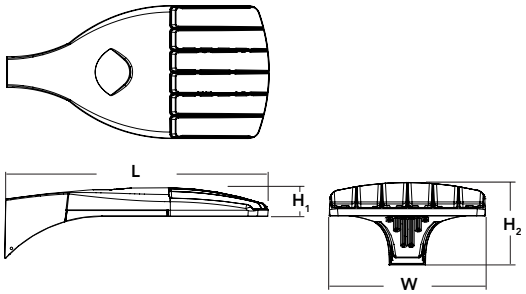
Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

EPA:	0.95 ft² (.09 m²)
Length:	26" (66.0 cm)
Width:	13" (33.0 cm)
Height$_1$:	3" (7.62 cm)
Height$_2$:	7" (17.8 cm)
Weight (max):	16 lbs (7.25 kg)



Introduction

The modern styling of the D-Series is striking yet unobtrusive - making a bold, progressive statement even as it blends seamlessly with its environment. The D-Series distills the benefits of the latest in LED technology into a high performance, high efficacy, long-life luminaire.

The outstanding photometric performance results in sites with excellent uniformity, greater pole spacing and lower power density. It is ideal for replacing up to 400W metal halide with typical energy savings of 70% and expected service life of over 100,000 hours.

OL2= M.H.= 12'-6"

ELECTRICAL CONTRACTOR TO DETERMINE MOUNTING REQUIREMENTS AND ACCESSORIES

Ordering Information

EXAMPLE: DSX0 LED P6 40K T3M MVOLT SPA NLTAIR2 PIRHN DDBXD G1

DSX0 LED

Series	LEDs	Color temperature	Distribution	Voltage	Mounting
DSX0 LED	**Forward optics** P1 P5 P2 P6 P3 P7[1] P4[1] **Rotated optics** P10[2] P12[2] P11[2] P13[1,2]	30K 3000 K 40K 4000 K 50K 5000 K	T1S Type I short (Automotive) T2S Type II short T2M Type II medium T3S Type III short T3M Type III medium T4M Type IV medium TFTM Forward throw medium T5VS Type V very short[3] T5S Type V short[3] T5M Type V medium[3] T5W Type V wide[3] BLC Backlight control[4] LCCO Left corner cutoff[4] RCCO Right corner cutoff[4]	MVOLT (120V-277V)[5,6] XVOLT (277V-480V)[7,8,9] 120[6] 208[6] 240[6] 277[6] 347[6] 480[6]	**Shipped included** SPA Square pole mounting RPA Round pole mounting[10] WBA Wall bracket[3] SPUMBA Square pole universal mounting adaptor[11] RPUMBA Round pole universal mounting adaptor[11] **Shipped separately** KMA8 DDBXD U Mast arm mounting bracket adaptor (specify finish)[12]

Control options		Other options	Finish *(required)*	Generation *(required)*
Shipped installed NLTAIR2 nLight AIR generation 2 enabled[13,14] PIRHN Network, high/low motion/ambient sensor[15] PER NEMA twist-lock receptacle only (control ordered separate)[16] PER5 Five-pin receptacle only (control ordered separate)[16,17] PER7 Seven-pin receptacle only (leads exit fixture) (control ordered separate)[16,17] DMG 0-10V dimming extend out back of housing for external control (control ordered separate)[18]	PIR High/low, motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 5fc[19,20] PIRH High/low, motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 5fc[19,20] PIR1FC3V High/low, motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 1fc[19,20] PIRH1FC3V High/low, motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 1fc[19,20] FAO Field adjustable output[19,21]	**Shipped installed** HS House-side shield[22] SF Single fuse (120, 277, 347V)[6] DF Double fuse (208, 240, 480V)[6] L90 Left rotated optics[2] R90 Right rotated optics[2] DDL Diffused drop lens[22] HA 50°C ambient operations[1] BAA Buy America(n) Act Compliant **Shipped separately** BS Bird spikes[23] EGS External glare shield	DDBXD Dark bronze DBLXD Black DNAXD Natural aluminum DWHXD White DDBTXD Textured dark bronze DBLBXD Textured black DNATXD Textured natural aluminum DWHGXD Textured white	G1 Generation 1

PROVIDE SHIELD WHERE INDICATED.

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Ordering Information

Accessories

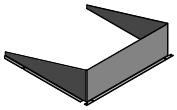
Ordered and shipped separately.

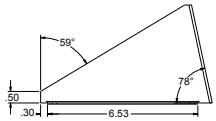
DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) [24]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V) [24]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V) [24]
DSHORT SBK U	Shorting cap [24]
DSX0HS 20C U G1	House-side shield for P1,P2,P3 and P4 [22]
DSX0HS 30C U G1	House-side shield for P10,P11,P12 and P13 [22]
DSX0HS 40C U G1	House-side shield for P5,P6 and P7 [22]
DSX0DDL U G1	Diffused drop lens (polycarbonate) [22]
PUMBA DDBXD U G1*	Square and round pole universal mounting bracket adaptor (specify finish) [25]
KMA8 DDBXD U	Mast arm mounting bracket adaptor (specify finish) [12]
DSX0EGS (FINISH) U G1	External glare shield

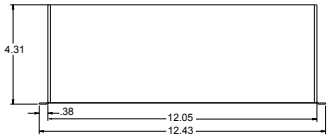
For more control options, visit DTL and ROAM online. Link to nLight Air 2

NOTES
1 HA not available with P4, P7, and P13.
2 P10, P11, P12 and P13 and rotated options (L90 or R90) only available together.
3 Any Type 5 distribution with photocell, is not available with WBA.
4 Not available with HS or DDL.
5 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
6 Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V. XVOLT not available with fusing (SF or DF).
7 XVOLT only suitable for use with P4, P7 and P13.
8 XVOLT operates with any voltage between 277V and 480V.
9 XVOLT not available with fusing (SF or DF) and not available with PIR, PIRH, PIR1FC3V, PIRH1FC3V.
10 Suitable for mounting to round poles between 3.5" and 12" diameter.
11 Universal mounting brackets intended for retrofit on existing pre-drilled poles only. 1.5 G vibration load rating per ANCI C136.31. Only usable when pole's drill pattern is NOT Lithonia template #8.
12 Must order fixture with SPA mounting. KMA8 must be ordered as a separate accessory; see Accessories information. For use with 2-3/8" diameter mast arm (not included).
13 Must be ordered with PIRHN.
14 Sensor cover available only in dark bronze, black, white and natural aluminum colors.
15 Must be ordered with NLTAIR2. For more information on nLight Air 2 visit this link.
16 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Shorting Cap included.
17 If ROAM® node required, it must be ordered and shipped as a separate line item from Acuity Brands Controls. Shorting Cap included.
18 DMG not available with PIRHN, PER5, PER7, PIR, PIRH, PIR1FC3V or PIRH1FC3V, FAO.
19 Reference Controls Options table on page 4.
20 Reference Motion Sensor Default Table on page 4 to see functionality.
21 Not available with other dimming controls options.
22 Not available with BLC, LCCO and RCCO distribution.
23 Must be ordered with fixture for factory pre-drilling.
24 Requires luminaire to be specified with PER, PER5 or PER7 option. See Controls Table on page 4.
25 For retrofit use only. Only usable when pole's drill pattern is NOT Lithonia template #8.

EGS – External Glare Shield

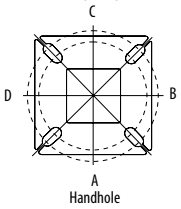


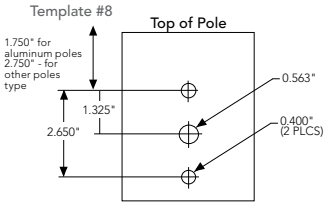




Drilling

HANDHOLE ORIENTATION
(from top of pole)





Tenon Mounting Slipfitter

Tenon O.D.	Mounting	Single Unit	2 @ 180	2 @ 90	3 @ 90	3 @120	4 @ 90
2-3/8"	RPA	AS3-5 190	AS3-5 280	AS3-5 290	AS3-5 390	AS3-5 320	AS3-5 490
2-7/8"	RPA	AST25-190	AST25-280	AST25-290	AST25-390	AST25-320	AST25-490
4"	RPA	AST35-190	AST35-280	AST35-290	AST35-390	AST35-320	AST35-490

							
Mounting Option	**Drilling Template**	**Single**	**2 @ 180**	**2 @ 90**	**3 @ 90**	**3 @ 120**	**4 @ 90**
Head Location		Side B	Side B & D	Side B & C	Side B, C & D	Round Pole Only	Side A, B, C & D
Drill Nomenclature	#8	DM19AS	DM28AS	DM29AS	DM39AS	DM32AS	DM49AS
		Minimum Acceptable Outside Pole Dimension					
SPA	#8	2-7/8"	2-7/8"	3.5"	3.5"		3.5"
RPA	#8	2-7/8"	2-7/8"	3.5"	3.5"	3"	3.5"
SPUMBA	#5	2-7/8"	3"	4"	4"		4"
RPUMBA	#5	2-7/8"	3.5"	5"	5"	3.5"	5"

DSX0 Area Luminaire - EPA

*Includes luminaire and integral mounting arm. Other tenons, arms, brackets or other accessories are not included in this EPA data.

Fixture Quantity & Mounting Configuration	Single DM19	2 @ 180 DM28	2 @ 90 DM29	3 @ 90 DM39	3 @ 120 DM32	4 @ 90 DM49
Mounting Type						
DSX0 LED	0.950	1.900	1.830	2.850	2.850	3.544

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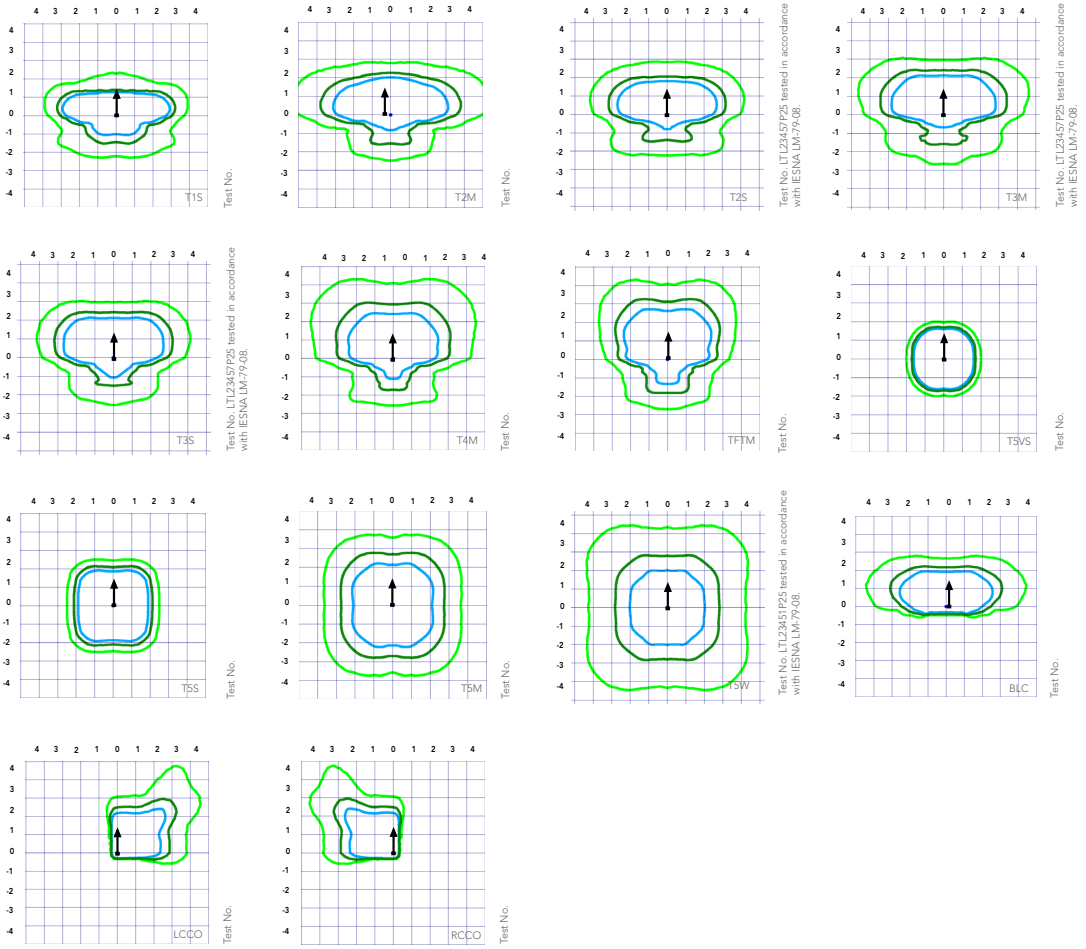
Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Area Size 0 homepage.

Isofootcandle plots for the DSX0 LED P6 40K G1. Distances are in units of mounting height (20').

LEGEND

- 0.1 fc
- 0.5 fc
- 1.0 fc



Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.04
5°C	41°F	1.04
10°C	50°F	1.03
15°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°F**	**1.00**
30°C	86°F	0.99
35°C	95°F	0.98
40°C	104°F	0.97

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the platforms noted in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	Lumen Maintenance Factor
25,000	0.96
50,000	0.92
100,000	0.85

Motion Sensor Default Settings						
Option	Dimmed State	High Level (when triggered)	Phototcell Operation	Dwell Time	Ramp-up Time	Ramp-down Time
PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	5 min	3 sec	5 min
*PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	5 min	3 sec	5 min
*for use when motion sensor is used as dusk to dawn control.						

Electrical Load

	Performance Package	LED Count	Drive Current	Wattage	Current (A) 120	208	240	277	347	480
Forward Optics (Non-Rotated)	P1	20	530	38	0.32	0.18	0.15	0.15	0.10	0.08
	P2	20	700	49	0.41	0.23	0.20	0.19	0.14	0.11
	P3	20	1050	71	0.60	0.37	0.32	0.27	0.21	0.15
	P4	20	1400	92	0.77	0.45	0.39	0.35	0.28	0.20
	P5	40	700	89	0.74	0.43	0.38	0.34	0.26	0.20
	P6	40	1050	134	1.13	0.65	0.55	0.48	0.39	0.29
	P7	40	1300	166	1.38	0.80	0.69	0.60	0.50	0.37
Rotated Optics (Requires L90 or R90)	P10	30	530	53	0.45	0.26	0.23	0.21	0.16	0.12
	P11	30	700	72	0.60	0.35	0.30	0.27	0.20	0.16
	P12	30	1050	104	0.88	0.50	0.44	0.39	0.31	0.23
	P13	30	1300	128	1.08	0.62	0.54	0.48	0.37	0.27

Controls Options

Nomenclature	Description	Functionality	Primary control device	Notes
FAO	Field adjustable output device installed inside the luminaire; wired to the driver dimming leads.	Allows the luminaire to be manually dimmed, effectively trimming the light output.	FAO device	Cannot be used with other controls options that need the 0-10V leads
DS	Drivers wired independently for 50/50 luminaire operation	The luminaire is wired to two separate circuits, allowing for 50/50 operation.	Independently wired drivers	Requires two separately switched circuits. Consider nLight AIR as a more cost effective alternative.
PER5 or PER7	Twist-lock photocell receptacle	Compatible with standard twist-lock photocells for dusk to dawn operation, or advanced control nodes that provide 0-10V dimming signals.	Twist-lock photocells such as DLL Elite or advanced control nodes such as ROAM.	Pins 4 & 5 to dimming leads on driver, Pins 6 & 7 are capped inside luminaire
PIR or PIRH	Motion sensors with integral photocell. PIR for 8-15' mounting; PIRH for 15-30' mounting	Luminaires dim when no occupancy is detected.	Acuity Controls SBGR	Also available with PIRH1FC3V when the sensor photocell is used for dusk-to-dawn operation.
NLTAIR2 PIRHN	nLight AIR enabled luminaire for motion sensing, photocell and wireless communication.	Motion and ambient light sensing with group response. Scheduled dimming with motion sensor over-ride when wirelessly connected to the nLight Eclypse.	nLight Air rSDGR	nLight AIR sensors can be programmed and commissioned from the ground using the CIAIRity Pro app.

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

Forward Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P1	20	530	38W	T1S	4,369	1	0	1	115	4,706	1	0	1	124	4,766	1	0	1	125
				T2S	4,387	1	0	1	115	4,726	1	0	1	124	4,785	1	0	1	126
				T2M	4,364	1	0	1	115	4,701	1	0	1	124	4,761	1	0	1	125
				T3S	4,376	1	0	1	115	4,714	1	0	1	124	4,774	1	0	1	126
				T3M	4,248	1	0	1	112	4,577	1	0	1	120	4,634	1	0	1	122
				T4M	4,281	1	0	1	113	4,612	1	0	2	121	4,670	1	0	2	123
				TFTM	4,373	1	0	1	115	4,711	1	0	2	124	4,771	1	0	2	126
				T5VS	4,548	2	0	0	120	4,900	2	0	0	129	4,962	2	0	0	131
				T5S	4,552	2	0	0	120	4,904	2	0	0	129	4,966	2	0	0	131
				T5M	4,541	3	0	1	120	4,891	3	0	1	129	4,953	3	0	1	130
				T5W	4,576	3	0	2	120	4,929	3	0	2	130	4,992	3	0	2	131
				BLC	3,586	1	0	1	94	3,863	1	0	1	102	3,912	1	0	1	103
				LCCO	2,668	1	0	1	70	2,874	1	0	2	76	2,911	1	0	2	77
				RCCO	2,668	1	0	1	70	2,874	1	0	2	76	2,911	1	0	2	77
P2	20	700	49W	T1S	5,570	1	0	1	114	6,001	1	0	1	122	6,077	2	0	2	124
				T2S	5,593	1	0	1	114	6,025	1	0	1	123	6,102	1	0	1	124
				T2M	5,564	1	0	2	114	5,994	1	0	2	122	6,070	2	0	2	125
				T3S	5,580	1	0	2	114	6,011	1	0	2	123	6,087	1	0	2	124
				T3M	5,417	1	0	2	111	5,835	1	0	2	119	5,909	2	0	2	121
				T4M	5,458	1	0	2	111	5,880	1	0	2	120	5,955	1	0	2	122
				TFTM	5,576	1	0	2	114	6,007	1	0	2	123	6,083	1	0	2	124
				T5VS	5,799	2	0	0	118	6,247	2	0	0	127	6,327	2	0	0	129
				T5S	5,804	2	0	0	118	6,252	2	0	0	128	6,332	2	0	1	129
				T5M	5,789	3	0	1	118	6,237	3	0	1	127	6,316	3	0	1	129
				T5W	5,834	3	0	2	119	6,285	3	0	2	128	6,364	3	0	2	130
				BLC	4,572	1	0	1	93	4,925	1	0	1	101	4,987	1	0	1	102
				LCCO	3,402	1	0	2	69	3,665	1	0	2	75	3,711	1	0	2	76
				RCCO	3,402	1	0	2	69	3,665	1	0	2	75	3,711	1	0	2	76
P3	20	1050	71W	T1S	7,833	2	0	2	110	8,438	2	0	2	119	8,545	2	0	2	120
				T2S	7,865	2	0	2	111	8,473	2	0	2	119	8,580	2	0	2	121
				T2M	7,825	2	0	2	110	8,429	2	0	2	119	8,536	2	0	2	120
				T3S	7,846	2	0	2	111	8,452	2	0	2	119	8,559	2	0	2	121
				T3M	7,617	2	0	2	107	8,205	2	0	2	116	8,309	2	0	2	117
				T4M	7,675	2	0	2	108	8,269	2	0	2	116	8,373	2	0	2	118
				TFTM	7,841	2	0	2	110	8,447	2	0	2	119	8,554	2	0	2	120
				T5VS	8,155	3	0	0	115	8,785	3	0	0	124	8,896	3	0	0	125
				T5S	8,162	3	0	1	115	8,792	3	0	1	124	8,904	3	0	1	125
				T5M	8,141	3	0	2	115	8,770	3	0	2	124	8,881	3	0	2	125
				T5W	8,204	3	0	2	116	8,838	4	0	2	124	8,950	4	0	2	126
				BLC	6,429	1	0	2	91	6,926	1	0	2	98	7,013	1	0	2	99
				LCCO	4,784	1	0	2	67	5,153	1	0	2	73	5,218	1	0	2	73
				RCCO	4,784	1	0	2	67	5,153	1	0	2	73	5,218	1	0	2	73
P4	20	1400	92W	T1S	9,791	2	0	2	106	10,547	2	0	2	115	10,681	2	0	2	116
				T2S	9,831	2	0	2	107	10,590	2	0	2	115	10,724	2	0	2	117
				T2M	9,780	2	0	2	106	10,536	2	0	2	115	10,669	2	0	2	116
				T3S	9,807	2	0	2	107	10,565	2	0	2	115	10,698	2	0	2	116
				T3M	9,521	2	0	2	103	10,256	2	0	2	111	10,386	2	0	2	113
				T4M	9,594	2	0	2	104	10,335	2	0	3	112	10,466	2	0	3	114
				TFTM	9,801	2	0	2	107	10,558	2	0	2	115	10,692	2	0	2	116
				T5VS	10,193	3	0	1	111	10,981	3	0	1	119	11,120	3	0	1	121
				T5S	10,201	3	0	1	111	10,990	3	0	1	119	11,129	3	0	1	121
				T5M	10,176	4	0	2	111	10,962	4	0	2	119	11,101	4	0	2	121
				T5W	10,254	4	0	3	111	11,047	4	0	3	120	11,186	4	0	3	122
				BLC	8,036	1	0	2	87	8,656	1	0	2	94	8,766	1	0	2	95
				LCCO	5,979	1	0	2	65	6,441	1	0	2	70	6,523	1	0	3	71
				RCCO	5,979	1	0	2	65	6,441	1	0	2	70	6,523	1	0	3	71

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

Forward Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P5	40	700	89W	T1S	10,831	2	0	2	122	11,668	2	0	2	131	11,816	2	0	2	133
				T2S	10,876	2	0	2	122	11,716	2	0	2	132	11,864	2	0	2	133
				T2M	10,820	2	0	2	122	11,656	2	0	2	131	11,803	2	0	2	133
				T3S	10,849	2	0	2	122	11,687	2	0	2	131	11,835	2	0	2	133
				T3M	10,532	2	0	2	118	11,346	2	0	2	127	11,490	2	0	2	129
				T4M	10,613	2	0	3	119	11,434	2	0	3	128	11,578	2	0	3	130
				TFTM	10,842	2	0	2	122	11,680	2	0	2	131	11,828	2	0	2	133
				T5VS	11,276	3	0	1	127	12,148	3	0	1	136	12,302	3	0	1	138
				T5S	11,286	3	0	1	127	12,158	3	0	1	137	12,312	3	0	1	138
				T5M	11,257	4	0	2	126	12,127	4	0	2	136	12,280	4	0	2	138
				T5W	11,344	4	0	3	127	12,221	4	0	3	137	12,375	4	0	3	139
				BLC	8,890	1	0	2	100	9,576	1	0	2	108	9,698	1	0	2	109
				LCCO	6,615	1	0	3	74	7,126	1	0	3	80	7,216	1	0	3	81
				RCCO	6,615	1	0	3	74	7,126	1	0	3	80	7,216	1	0	3	81
P6	40	1050	134W	T1S	14,805	3	0	3	110	15,949	3	0	3	119	16,151	3	0	3	121
				T2S	14,865	3	0	3	111	16,014	3	0	3	120	16,217	3	0	3	121
				T2M	14,789	3	0	3	110	15,932	3	0	3	119	16,134	3	0	3	120
				T3S	14,829	2	0	3	111	15,975	3	0	3	119	16,177	3	0	3	121
				T3M	14,396	3	0	3	107	15,509	3	0	3	116	15,705	3	0	3	117
				T4M	14,507	2	0	3	108	15,628	3	0	3	117	15,826	3	0	3	118
				TFTM	14,820	2	0	3	111	15,965	3	0	3	119	16,167	3	0	3	121
				T5VS	15,413	4	0	1	115	16,604	4	0	1	124	16,815	4	0	1	125
				T5S	15,426	3	0	1	115	16,618	4	0	1	124	16,828	4	0	1	126
				T5M	15,387	4	0	2	115	16,576	4	0	2	124	16,786	4	0	2	125
				T5W	15,506	4	0	3	116	16,704	4	0	3	125	16,915	4	0	3	126
				BLC	12,151	1	0	2	91	13,090	1	0	2	98	13,255	1	0	2	99
				LCCO	9,041	1	0	3	67	9,740	1	0	3	73	9,863	1	0	3	74
				RCCO	9,041	1	0	3	67	9,740	1	0	3	73	9,863	1	0	3	74
P7	40	1300	166W	T1S	17,023	3	0	3	103	18,338	3	0	3	110	18,570	3	0	3	112
				T2S	17,092	3	0	3	103	18,413	3	0	3	111	18,646	3	0	3	112
				T2M	17,005	3	0	3	102	18,319	3	0	3	110	18,551	3	0	3	112
				T3S	17,051	3	0	3	103	18,369	3	0	3	111	18,601	3	0	3	112
				T3M	16,553	3	0	3	100	17,832	3	0	3	107	18,058	3	0	3	109
				T4M	16,681	3	0	3	100	17,969	3	0	3	108	18,197	3	0	3	110
				TFTM	17,040	3	0	3	103	18,357	3	0	4	111	18,590	3	0	4	112
				T5VS	17,723	4	0	1	107	19,092	4	0	1	115	19,334	4	0	1	116
				T5S	17,737	4	0	2	107	19,108	4	0	2	115	19,349	4	0	2	117
				T5M	17,692	4	0	2	107	19,059	4	0	2	115	19,301	4	0	2	116
				T5W	17,829	5	0	3	107	19,207	5	0	3	116	19,450	5	0	3	117
				BLC	13,971	2	0	2	84	15,051	2	0	2	91	15,241	2	0	2	92
				LCCO	10,396	1	0	3	63	11,199	1	0	3	67	11,341	1	0	3	68
				RCCO	10,396	1	0	3	63	11,199	1	0	3	67	11,341	1	0	3	68

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

Rotated Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P10	30	530	53W	T1S	6,727	2	0	2	127	7,247	3	0	3	137	7,339	3	0	3	138
				T2S	6,809	3	0	3	128	7,336	3	0	3	138	7,428	3	0	3	140
				T2M	6,689	3	0	3	126	7,205	3	0	3	136	7,297	3	0	3	138
				T3S	6,805	3	0	3	128	7,331	3	0	3	138	7,424	3	0	3	140
				T3M	6,585	3	0	3	124	7,094	3	0	3	134	7,183	3	0	3	136
				T4M	6,677	3	0	3	126	7,193	3	0	3	136	7,284	3	0	3	137
				TFTM	6,850	3	0	3	129	7,379	3	0	3	139	7,472	3	0	3	141
				T5VS	6,898	3	0	0	130	7,431	3	0	0	140	7,525	3	0	0	142
				T5S	6,840	2	0	1	129	7,368	2	0	1	139	7,461	2	0	1	141
				T5M	6,838	3	0	1	129	7,366	3	0	2	139	7,460	3	0	2	141
				T5W	6,777	3	0	2	128	7,300	3	0	2	138	7,393	3	0	2	139
				BLC	5,626	2	0	2	106	6,060	2	0	2	114	6,137	2	0	2	116
				LCCO	4,018	1	0	2	76	4,328	1	0	2	82	4,383	1	0	2	83
				RCCO	4,013	3	0	3	76	4,323	3	0	3	82	4,377	3	0	3	83
P11	30	700	72W	T1S	8,594	3	0	3	119	9,258	3	0	3	129	9,376	3	0	3	130
				T2S	8,699	3	0	3	121	9,371	3	0	3	130	9,490	3	0	3	132
				T2M	8,545	3	0	3	119	9,205	3	0	3	128	9,322	3	0	3	129
				T3S	8,694	3	0	3	121	9,366	3	0	3	130	9,484	3	0	3	132
				T3M	8,412	3	0	3	117	9,062	3	0	3	126	9,177	3	0	3	127
				T4M	8,530	3	0	3	118	9,189	3	0	3	128	9,305	3	0	3	129
				TFTM	8,750	3	0	3	122	9,427	3	0	3	131	9,546	3	0	3	133
				T5VS	8,812	3	0	0	122	9,493	3	0	0	132	9,613	3	0	0	134
				T5S	8,738	3	0	1	121	9,413	3	0	1	131	9,532	3	0	1	132
				T5M	8,736	3	0	2	121	9,411	3	0	2	131	9,530	3	0	2	132
				T5W	8,657	4	0	2	120	9,326	4	0	2	130	9,444	4	0	2	131
				BLC	7,187	3	0	3	100	7,742	3	0	3	108	7,840	3	0	3	109
				LCCO	5,133	1	0	2	71	5,529	1	0	2	77	5,599	1	0	2	78
				RCCO	5,126	3	0	3	71	5,522	3	0	3	77	5,592	3	0	3	78
P12	30	1050	104W	T1S	12,149	3	0	3	117	13,088	3	0	3	126	13,253	3	0	3	127
				T2S	12,297	3	0	3	118	13,247	3	0	3	127	13,415	3	0	3	129
				T2M	12,079	4	0	4	116	13,012	4	0	4	125	13,177	4	0	4	127
				T3S	12,290	3	0	3	118	13,239	4	0	4	127	13,407	4	0	4	129
				T3M	11,891	4	0	4	114	12,810	4	0	4	123	12,972	4	0	4	125
				T4M	12,058	4	0	4	116	12,990	4	0	4	125	13,154	4	0	4	126
				TFTM	12,369	4	0	4	119	13,325	4	0	4	128	13,494	4	0	4	130
				T5VS	12,456	3	0	1	120	13,419	3	0	1	129	13,589	4	0	1	131
				T5S	12,351	3	0	1	119	13,306	3	0	1	128	13,474	3	0	1	130
				T5M	12,349	4	0	2	119	13,303	4	0	2	128	13,471	4	0	2	130
				T5W	12,238	4	0	3	118	13,183	4	0	3	127	13,350	4	0	3	128
				BLC	10,159	3	0	3	98	10,944	3	0	3	105	11,083	3	0	3	107
				LCCO	7,256	1	0	3	70	7,816	1	0	3	75	7,915	1	0	3	76
				RCCO	7,246	3	0	3	70	7,806	4	0	4	75	7,905	4	0	4	76
P13	30	1300	128W	T1S	14,438	3	0	3	113	15,554	3	0	3	122	15,751	3	0	3	123
				T2S	14,614	3	0	3	114	15,744	4	0	4	123	15,943	4	0	4	125
				T2M	14,355	4	0	4	112	15,465	4	0	4	121	15,660	4	0	4	122
				T3S	14,606	4	0	4	114	15,735	4	0	4	123	15,934	4	0	4	124
				T3M	14,132	4	0	4	110	15,224	4	0	4	119	15,417	4	0	4	120
				T4M	14,330	4	0	4	112	15,438	4	0	4	121	15,633	4	0	4	122
				TFTM	14,701	4	0	4	115	15,836	4	0	4	124	16,037	4	0	4	125
				T5VS	14,804	4	0	1	116	15,948	4	0	1	125	16,150	4	0	1	126
				T5S	14,679	3	0	1	115	15,814	3	0	1	124	16,014	3	0	1	125
				T5M	14,676	4	0	2	115	15,810	4	0	2	124	16,010	4	0	2	125
				T5W	14,544	4	0	3	114	15,668	4	0	3	122	15,866	4	0	3	124
				BLC	7919	3	0	3	62	8531	3	0	3	67	8639	3	0	3	67
				LCCO	5145	1	0	2	40	5543	1	0	2	43	5613	1	0	2	44
				RCCO	5139	3	0	3	40	5536	3	0	3	43	5606	3	0	3	44

FEATURES & SPECIFICATIONS

INTENDED USE
The sleek design of the D-Series Size 0 reflects the embedded high performance LED technology. It is ideal for many commercial and municipal applications, such as parking lots, plazas, campuses, and pedestrian areas.

CONSTRUCTION
Single-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance and future light engine upgrades. The LED driver is mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65). Low EPA (0.95 ft^2) for optimized pole wind loading.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in both textured and non-textured finishes.

OPTICS
Precision-molded proprietary acrylic lenses are engineered for superior area lighting distribution, uniformity, and pole spacing. Light engines are available in 3000 K, 4000 K or 5000 K (70 CRI) configurations. The D-Series Size 0 has zero uplight and qualifies as a Nighttime Friendly™ product, meaning it is consistent with the LEED® and Green Globes™ criteria for eliminating wasteful uplight.

ELECTRICAL
Light engine(s) configurations consist of high-efficacy LEDs mounted to metal-core circuit boards to maximize heat dissipation and promote long life (up to L85/100,000 hours at 25°C). Class 1 electronic drivers are designed to have a power factor >90%, THD <20%, and an expected life of 100,000 hours with <1% failure rate. Easily serviceable 10kV surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

STANDARD CONTROLS
The DSX0 LED area luminaire has a number of control options. DSX Size 0, comes standard with 0-10V dimming driver. Dusk to dawn controls can be utilized via optional NEMA twist-lock photocell receptacles. Integrated motion sensors with on-board photocells feature field-adjustable programing and are suitable for mounting heights up to 30 feet.

nLIGHT AIR CONTROLS
The DSX0 LED area luminaire is also available with nLight® AIR for the ultimate in wireless control. This powerful controls platform provides out-of-the-box basic motion sensing and photocontrol functionality and is suitable for mounting heights up to 40 feet. Once commissioned using a smartphone and the easy-to-use CLAIRITY app, nLight AIR equipped luminaries can be grouped, resulting in motion sensor and photocell group response without the need for additional equipment. Scheduled dimming with motion sensor over-ride can be achieved when used with the nLight Eclypse. Additional information about nLight Air can be found here.

INSTALLATION
Included mounting block and integral arm facilitate quick and easy installation. Stainless steel bolts fasten the mounting block securely to poles and walls, enabling the D-Series Size 0 to withstand up to a 3.0 G vibration load rating per ANSI C136.31. The D-Series Size 0 utilizes the AERIS™ series pole drilling pattern (template #8). Optional terminal block and NEMA photocontrol receptacle are also available.

LISTINGS
UL listed to meet U.S. and Canadian standards. UL Listed for wet locations. Light engines are IP66 rated; luminaire is IP65 rated. Rated for -40°C to 50°C ambient with HA option. U.S. Patent No. D672,492 S. International patent pending.

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.

International Dark-Sky Association (IDA) Fixture Seal of Approval (FSA) is available for all products on this page utilizing 3000K color temperature only.

BUY AMERICAN
Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. 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.

TYPE OL3

Lumière

		Type
Catalog #		
Project		
Comments		Date
Prepared by		

DESCRIPTION

Monaco 3002A is a small scale, versatile and adjustable LED inground illuminator providing up to 25° tilt and 360° rotation of lamp beam allowing for precision aiming.The Monaco 3002A is ideal for uplighting building facades, trees, columns, and other interesting site features.

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURERS OR ENGINEER-APPROVED EQUAL.

SPECIFICATION FEATURES

Material
Recessed housing is constructed from corrosion-proof, injection molded polyphenylene sulfide (PPS). Trim ring is constructed from corrosion-resistant brass or stainless steel.

Finish
Painted trim rings are constructed from solid brass with a polyester powdercoat paint finish. A variety of standard colors is available. Machined natural brass or stainless steel trim rings are unpainted and available in either round or square forms. Brass will patina naturally over time. Options to meet Buy American Act requirements

Lens
Domed 1/2" thick tempered glass lens, factory sealed with high temperature gasket to prevent water intrusion. Suitable for drive-over* applications to 5000 lbs.

Hardware
Stainless steel hardware is standard to provide maximum corrosion-resistance. Outer trim ring includes captive fasteners.

Electrical
LED fixtures include an integral, universal input driver (120V - 277V).

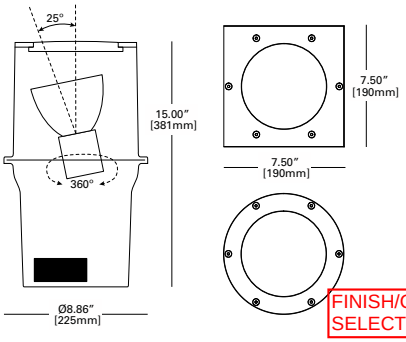
LED Light Engine
LED light engine is included and comes equipped with (7) 3-watt white LEDs. Factory configurable optics allow for four optical distributions. High CRI of 85 with excellent color consistency of +/-50K color temperature.

Dimming
The LED light engine is dimmable to 15% with electronic low voltage equipment (ELV dimmers need a neutral connection in the wall box).

Warranty
Lumiere warrants it's fixtures against defects in materials & workmanship for three (3) years. Driver carries the original manufacturer's warranty.

Recessed Housing
Recessed housing is provided with two 3/4 inch NPS threaded conduit entries. The recessed housing is available to ship in advance of complete fixture for rough-in purposes. Specify option -LBB and order recessed housing and accompanying components from below:

Recessed housing:
3000-BBR
3000-BBS
Recessed housing with fusing:
3000-BBR-FUS
3000-BBS-FUS



FINISH/COLOR AS SELECTED BY ARCHITECT.

MONAKO

3002A
LED

APPLICATIONS:
ADJUSTABLE INGROUND

CERTIFICATION DATA
UL and cUL Wet Location Listed
LM79 / LM80 Compliant
ROHS Compliant
IP68 Ingressed Protection Rated

TECHNICAL DATA
25 Watt Max. LED
50°C Maximum Temperature Rating

ORDERING INFORMATION

Sample Number: 3002A-RD-18LED3000-MFL-CLR-UNV-BZ

Domestic Preferences [1]	Series	Trim	Source	Distribution	Top Glass	Voltage	Finish [1,3]	Other
[Blank]=Standard **BAA**=Buy American Act	**3002A**=Monaco 3002 LED Adjustable Aiming	**RD**=Round **SQ**=Square	**18LED2700**= 18W LED, 2700K, 85 CRI **18LED3000**= 18W LED, 3000K, 85 CRI **18LED3500**= 18W LED, 3500K, 85 CRI **18LED4000**= 18W LED, 4000K, 85 CRI **25LED2700**= 25W LED, 2700K, 85 CRI **25LED3000**= 25W LED, 3000K, 85 CRI **25LED3500**= 25W LED, 3500K, 85 CRI **25LED4000**= 25W LED, 4000K, 85 CRI	**SP**=9° Spot **NFL**=15° Narrow Flood **MFL**=25° Medium Flood **WFL**=40° Wide Flood	**CLR**=Clear Top Glass **DIF**=Diffuse Top Glass **NSL**=Non-Slip Lens	**UNV**=120-277V 50/60Hz, electronic driver	**Painted** **BK**=Black **BZ**=Bronze **CS**=City Silver **VE**=Verde **WT**=White	**LBB**=Less Back Box **FUS**=Fusing

*Drive over fixtures not qualified for roadway or heavy traffic applications.

NOTES: **1** Only product configurations with this designated prefix are built to be compliant with the Buy American Act of 1933 (BAA). Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements. **2.** Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information. **3.** Consult factory for premium/natural metals material finish.

COOPER Lighting Solutions

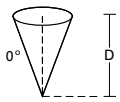
ACCESSORIES [2]

Filters (4.95" Diameter)	Optical Lenses (4.95" Diameter)	Optical Louvers (4.95" Diameter)	Light Control	Electrical
F71-38 = Peach Dichroic **F72-38** = Amber Dichroic **F73-38** = Green Dichroic **F74-38** = Medium Blue **F75-38** = Yellow Dichroic **F76-38** = Red Dichroic **F77-38** = Dark Blue Dichroic **F78-38** = Light Blue Dichroic **F79-38** = Neutral Density Dichroic **F80-38** = Magenta Dichroic **F22-38** = Red Color **F33-38** = Blue Color **F44-38** = Green Color **F55-38** = Yellow Color **F66-38** = Mercury Vapor	**LSL-38**=Linear Spread Lens (elongates standard beam spread) **DIF-38**=Diffused Lens (provides even illumination) **OSL-38**=Overall Spread Lens (increases standard beam spread)	**LVR-38**=45° Hex Cell Louver (reduces glare)	**3000-RG**=Rock Guard **3000-SG**=Straight Glare Shield **3000-AG**=Above Ground	**3000-FUS**=Fusing Package

PHOTOMETRY

3002A-18LED3000-SP	
Test No.	P166840
CCT	3000K
Lumens	967 Lm
Watts	16.6 W
LPW	58.3 Lm/W
Beam Angle	8.9°
Field Angle	17.2°
CBCP	30118 cd

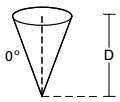
CONE OF LIGHT



D	FC	L	W
10′	301.2	1.4	1.4
20′	75.3	3	3
30′	33.5	4.6	4.6
40′	18.8	6.2	6.2

3002A-18LED3000-NFL	
Test No.	P166839
CCT	3000K
Lumens	971 Lm
Watts	16.6 W
LPW	58.5 Lm/W
Beam Angle	13.9°
Field Angle	24°
CBCP	14995 cd

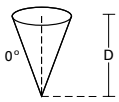
CONE OF LIGHT



D	FC	L	W
10′	149.9	2.4	2.4
20′	37.5	4.8	4.8
30′	16.7	7.2	7.2
40′	9.4	9.6	9.6

3002A-18LED3000-MFL	
Test No.	P166838
CCT	3000K
Lumens	912 Lm
Watts	16.6 W
LPW	55.5 Lm/W
Beam Angle	22.8°
Field Angle	48.7°
CBCP	4010 cd

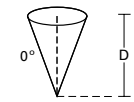
CONE OF LIGHT



D	FC	L	W
10′	40.1	3.8	3.8
20′	10	7.6	7.6
30′	4.5	11.4	11.4
40′	2.5	15.2	15.2

3002A-18LED3000-WFL	
Test No.	P166841
CCT	3000K
Lumens	947 Lm
Watts	16.6 W
LPW	57.0 Lm/W
Beam Angle	36.2°
Field Angle	53.2°
CBCP	2674 cd

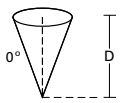
CONE OF LIGHT



D	FC	L	W
10′	26.7	6	6
20′	6.7	12	12
30′	3	18	18
40′	1.7	23.4	23.4

3002A-25LED3000-SP	
Test No.	P253142
CCT	3000K
Lumens	1232 Lm
Watts	25.1 W
LPW	49.1 Lm/W
Beam Angle	8.9°
Field Angle	17.2°
CBCP	38343 cd

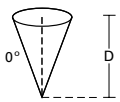
CONE OF LIGHT



D	FC	L	W
10′	383.4	1.4	1.4
20′	95.9	3	3
30′	42.6	4.6	4.6
40′	24	6.2	6.2

3002A-25LED3000-NFL	
Test No.	P253141
CCT	3000K
Lumens	1237 Lm
Watts	25.1 W
LPW	49.3 Lm/W
Beam Angle	13.9°
Field Angle	24.0°
CBCP	19090 cd

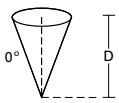
CONE OF LIGHT



D	FC	L	W
10′	172.2	2.4	2.4
20′	43.1	4.8	4.8
30′	19.1	7.2	7.2
40′	10.8	9	9

3002A-25LED3000-MFL	
Test No.	P253140
CCT	3000K
Lumens	1162 Lm
Watts	16.7 W
LPW	46.3 Lm/W
Beam Angle	22.8°
Field Angle	48.7°
CBCP	5104 cd

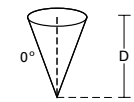
CONE OF LIGHT



D	FC	L	W
10′	51	3.8	3.8
20′	12.8	7.6	7.6
30′	5.7	11.4	11.4
40′	3.2	15.2	15.2

3002A-25LED3000-WFL	
Test No.	P253143
CCT	3000K
Lumens	1205 Lm
Watts	25.1 W
LPW	48 Lm/W
Beam Angle	36.2°
Field Angle	53.2°
CBCP	3404 cd

CONE OF LIGHT



D	FC	L	W
10′	34	6	6
20′	8.5	12	12
30′	3.8	18	18
40′	2.1	23.4	23.4

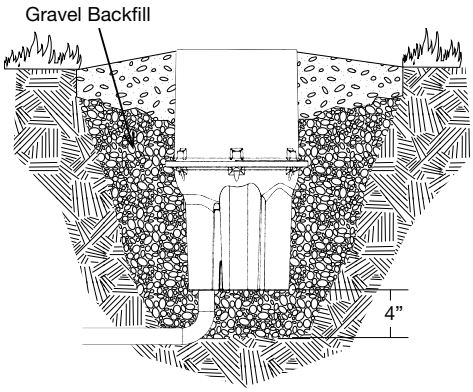
CCT/CRI	2700K / 90 CRI	3000K / 80 CRI	3500K / 80 CRI	4000K / 80 CRI
Lumen Multiplier	0.729	1.000	1.123	1.057

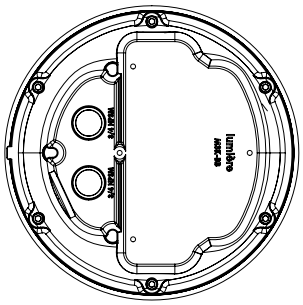
TECHNICAL NOTES

INSTALLATION NOTES

Caution: To prevent water, dirt and debris from collecting, install fixture to allow runoff. Do not install fixture in areas where water can collect for long periods of time. Appropriate drainage must be provided.

Excavated hole must be approximately 15" in diameter by 20" in depth. Fixture must be installed with a minimum 4" depth of pea gravel or equivalent drainage base. Backfill an additional 8" depth of pea gravel on lower portion of fixture for soil stability. For more detailed installation instructions and warnings consult factory.





Bottom view of recessed housing showing two 3/4 inch NPS conduit entries.

WST LED

Architectural Wall Sconce

Buy American

TYPE OL4

Catalog Number

Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

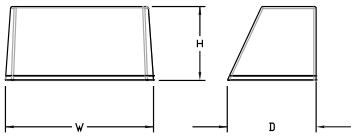
Luminaire

Height: 8-1/2" *(21.59 cm)*

Width: 17" *(43.18 cm)*

Depth: 10-3/16" *(25.9 cm)*

Weight: 20 lbs *(9.1 kg)*



Introduction

The WST LED is designed with the specifier in mind. The traditional, trapezoidal shape offers a soft, non-pixilated light source for end-user visual comfort. For emergency egress lighting, the WST LED offers six battery options, including remote. For additional code compliance and energy savings, there is also a Bi-level motion sensor option. With so many standard and optional features, three lumen packages, and high LPW, the WST LED is your "go to" luminaire for most any application.

A+ Capable options indicated by this color background.

OL4

Ordering Information

EXAMPLE: WST LED P1 40K VF MVOLT DDBTXD

WST LED					
Series	**Performance Package**	**Color temperature**	**Distribution**	**Voltage**	**Mounting**
WST LED	P1 1,500 Lumen package P2 3,000 Lumen package P3 6,000 Lumen package	27K 2700 K 30K 3000 K 40K 4000 K 50K 5000 K	VF Visual comfort forward throw VW Visual comfort wide	MVOLT[1] 120[2] 208[2] 240[2] 277[2] 347[2] 480[2]	**Shipped included** (blank) Surface mounting bracket PBBW Premium surface-mounted back box[3,4] **Shipped separately** BBW Surface-mounted back box[3]

Options

NLTAIR2 PIR	nLIGHT AIR Wireless enabled motion/ambient sensor for 8'-15' mounting heights[5,6,7]
NLTAIR2 PIRH	nLIGHT AIR Wireless enabled motion/ambient sensor for 15'-30' mounting heights[5,6,7]
PE	Photoelectric cell, button type[8]
PER	NEMA twist-lock receptacle only (controls ordered separate)[9]
PER5	Five-wire receptacle only (controls ordered separate)[9]
PER7	Seven-wire receptacle only (controls ordered separate)[9]
PIR	Motion/Ambient Light Sensor, 8-15' mounting height[5,6]
PIR1FC3V	Motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 1fc[5,6]
PIRH	180° motion/ambient light sensor, 15-30' mounting height[5,6]
PIRH1FC3V	Motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 1fc[5,6]
SF	Single fuse (120, 277, 347V)[2]
DF	Double fuse (208, 240, 480V)[2]
DS	Dual switching[10]
DMG	0-10V dimming extend out back of housing for external control (control ordered separate)[11]
E7WH	Emergency battery backup, Non CEC compliant (7W)[7]
E7WC	Emergency battery backup, CA Title 20 Noncompliant (cold, 7W)[7,12]
E7WHR	Remote emergency battery backup, CA Title 20 Noncompliant (remote 7W)[7,13]
E20WH	Emergency battery pack 18W constant power, Certified in CA Title 20 MAEDBS[7]
E20WC	Emergency battery pack -20°C 18W constant power, Certified in CA Title 20 MAEDBS[7,12]
E23WHR	Remote emergency battery backup, CA Title 20 Noncompliant (remote 20W)[7,12,14]
LCE	Left side conduit entry[15]
RCE	Right side conduit entry[15]
BAA	Buy America(n) Act Compliant

Shipped separately

RBPW	Retrofit back plate[3]
VG	Vandal guard[15]
WG	Wire guard[15]

Finish *(required)*

DDBXD	Dark bronze
DBLXD	Black
DNAXD	Natural aluminum
DWHXD	White
DSSXD	Sandstone
DDBTXD	Textured dark bronze
DBLBXD	Textured black
DNATXD	Textured natural aluminum
DWHGXD	Textured white
DSSTXD	Textured sandstone

See Accessories and Notes on next page.

Accessories

Ordered and shipped separately.

WSTVCPBBW DDBXD U	Premium Surface - mounted back box
WSBBW DDBTXD U	Surface - mounted back box
RBPW DDBXD U	Retrofit back plate
DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V)[17]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V)[17]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V)[17]

NOTES

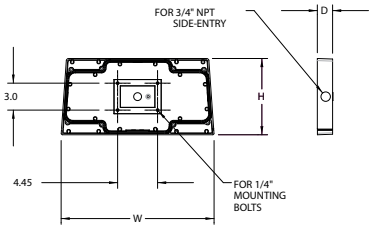
1 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
2 Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V.
3 Also available as a separate accessory; see accessories information.
4 Top conduit entry standard.
5 Not available with VG or WG. See PER Table.
6 Reference Motion Sensor table.
7 Not available with 347/480V.
8 Need to specify 120, 208, 240 or 277 voltage.
9 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. Shorting Cap included.
10 Not available with Emergency options, PE or PER options.
11 DMG option not available with standalone or networked sensors/controls.
12 Battery pack rated for -20° to 40°C.
13 Comes with PBBW.
14 Warranty period is 3-years.
15 Not available with BBW.
16 Must order with fixture; not an accessory.
17 Requires luminaire to be specified with PER, PER5 or PER7 option. See PER Table.

Optional Back Box (PBBW)

Height: 8.49″ *(21.56 cm)*

Width: 17.01″ *(43.21 cm)*

Depth: 1.70″ *(4.32 cm)*

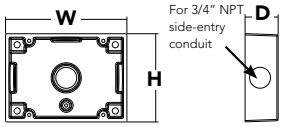


Optional Back Box (BBW)

Height: 4″ *(10.2 cm)*

Width: 5-1/2″ *(14.0 cm)*

Depth: 1-1/2″ *(3.8 cm)*



Emergency Battery Operation

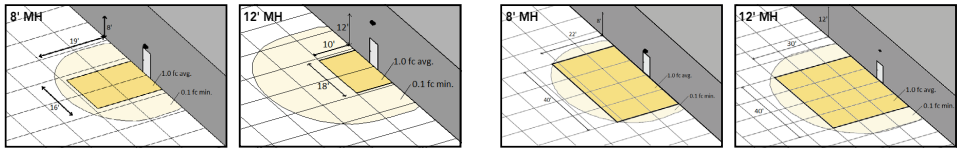
The emergency battery backup is integral to the luminaire — no external housing required! This design provides reliable emergency operation while maintaining the aesthetics of the product.

All emergency backup configurations include an independent secondary driver with an integral relay to immediately detect AC power loss, meeting interpretations of NFPA 70/NEC 2008 - 700.16

The emergency battery will power the luminaire for a minimum duration of 90 minutes (maximum duration of three hours) from the time supply power is lost, per International Building Code Section 1006 and NFPA 101 Life Safety Code Section 7.9, provided luminaires are mounted at an appropriate height and illuminate an open space with no major obstructions.

The examples below show illuminance of 1 fc average and 0.1 fc minimum of the P1 power package and VF distribution product in emergency mode.

10' x 10' Gridlines
8' and 12' Mounting Height



WST LED P1 27K VF MVOLT E7WH

WST LED P2 40K VF MVOLT E20WH

Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.03
10°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°F**	**1.00**
30°C	86°F	0.99
40°C	104°F	0.98

Projected LED Lumen Maintenance

Values calculated according to IESNA TM-21-11 methodology and valid up to 40°C.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	>0.95	>0.92	>0.87

Electrical Load

Performance package	System Watts	Current (A)					
		120	208	240	277	347	480
P1	11	0.1	0.06	0.05	0.04	---	---
	14	---	---	---	---	0.04	0.03
P1 DS	14	0.12	0.07	0.06	0.06	---	---
P2	25	0.21	0.13	0.11	0.1	---	---
	30	---	---	---	---	0.09	0.06
P2 DS	25	0.21	0.13	0.11	0.1	---	---
P3	50	0.42	0.24	0.21	0.19	---	---
	56	---	---	---	---	0.16	0.12
P3 DS	52	0.43	0.26	0.23	0.21	---	---

Motion Sensor Default Settings

Option	Dimmed State	High Level (when triggered)	Photocell Operation	Ramp-up Time	Dwell Time	Ramp-down Time
*PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	3 sec	5 min	5 min
PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	3 sec	5 min	5 min

*for use with site wide Dusk to Dawn control

PER Table

Control	PER (3 wire)	PER5 (5 wire)		PER7 (7 wire)		
			Wire 4/Wire5		Wire 4/Wire5	Wire 6/Wire7
Photocontrol Only (On/Off)	✓	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM	⊘	✓	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM with Motion	⊘	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof*	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof* with Motion	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture

✓ Recommended

⊘ Will not work

⚠ Alternate

*Futureproof means: Ability to change controls in the future.

Lumen Output

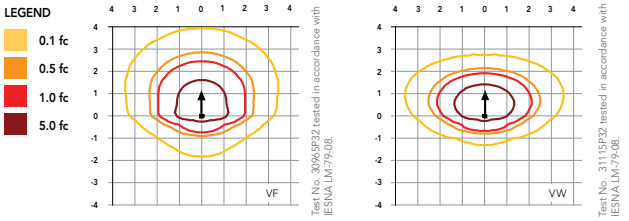
Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts.

Performance Package	System Watts (MVOLT[1])	Dist. Type	27K (2700K, 70 CRI)					30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)				
			Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P1	12W	VF	1,494	0	0	0	125	1,529	0	0	0	127	1,639	0	0	0	137	1,639	0	0	0	137
		VW	1,513	0	0	0	126	1,548	0	0	0	129	1,659	0	0	0	138	1,660	0	0	0	138
P2	25W	VF	3,163	1	0	1	127	3,237	1	0	1	129	3,469	1	0	1	139	3,468	1	0	1	139
		VW	3,201	1	0	0	128	3,276	1	0	0	131	3,512	1	0	0	140	3,512	1	0	0	140
P3	50W	VF	6,025	1	0	1	121	6,165	1	0	1	123	6,609	1	0	1	132	6,607	1	0	1	132
		VW	6,098	1	0	1	122	6,240	1	0	1	125	6,689	1	0	1	134	6,691	1	0	1	134

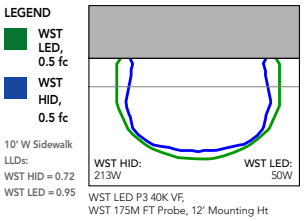
Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's WST LED homepage.

Isofootcandle plots for the WST LED P3 40K VF and VW. Distances are in units of mounting height (10').



Distribution overlay comparison to 175W metal halide.



FEATURES & SPECIFICATIONS

INTENDED USE
The classic architectural shape of the WST LED was designed for applications such as hospitals, schools, malls, restaurants, and commercial buildings. The long life LEDs and driver make this luminaire nearly maintenance-free.

CONSTRUCTION
The single-piece die-cast aluminum housing integrates secondary heat sinks to optimize thermal transfer from the internal light engine heat sinks and promote long life. The driver is mounted in direct contact with the casting for a low operating temperature and long life. The die-cast door frame is fully gasketed with a one-piece solid silicone gasket to keep out moisture and dust, providing an IP65 rating for the luminaire.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Standard Super Durable colors include dark bronze, black, natural aluminum, sandstone and white. Available in textured and non-textured finishes.

OPTICS
Well crafted reflector optics allow the light engine to be recessed within the luminaire, providing visual comfort, superior distribution, uniformity, and spacing in wall-mount applications. The WST LED has zero uplight and qualifies as a Nighttime Friendly™ product, meaning it is consistent with the LEED® and Green Globes™ criteria for eliminating wasteful uplight.

ELECTRICAL
Light engine(s) consist of 98 high-efficacy LEDs mounted to a metal core circuit board and integral aluminum heat sinks to maximize heat dissipation and promote long life (100,000 hrs at 40°C, L87). Class 2 electronic driver has a power factor >90%, THD <20%. Easily-serviceable surge protection device meets a minimum Category B (per ANSI/IEEE C62.41.2).

INSTALLATION
A universal mounting plate with integral mounting support arms allows the fixture to hinge down for easy access while making wiring connections.

LISTINGS
CSA certified to U.S. and Canadian standards. Luminaire is IP65 rated. PIR and back box options are rated for wet location. Rated for -30°C to 40°C ambient.

BUY AMERICAN
Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT. 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.

WST LED

Architectural Wall Sconce

Buy American

TYPE OL5

Catalog Number

Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

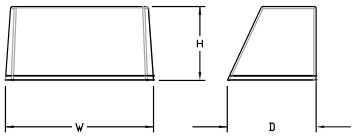
Luminaire

Height: 8-1/2" *(21.59 cm)*

Width: 17" *(43.18 cm)*

Depth: 10-3/16" *(25.9 cm)*

Weight: 20 lbs *(9.1 kg)*



OL5

A+ Capable options indicated by this color background.

Introduction

The WST LED is designed with the specifier in mind. The traditional, trapezoidal shape offers a soft, non-pixilated light source for end-user visual comfort. For emergency egress lighting, the WST LED offers six battery options, including remote. For additional code compliance and energy savings, there is also a Bi-level motion sensor option. With so many standard and optional features, three lumen packages, and high LPW, the WST LED is your "go to" luminaire for most any application.

Ordering Information

EXAMPLE: WST LED P1 40K VF MVOLT DDBTXD

WST LED

Series	Performance Package	Color temperature	Distribution	Voltage	Mounting
WST LED	P1 1,500 Lumen package	27K 2700 K	VF Visual comfort forward throw	MVOLT[1]	277[2]
	P2 3,000 Lumen package	30K 3000 K	VW Visual comfort wide	120[2]	347[2]
	P3 6,000 Lumen package	40K 4000 K		208[2]	480[2]
		50K 5000 K		240[2]	**Shipped included**
					(blank) Surface mounting bracket
					PBBW Premium surface-mounted back box[3,4]
					Shipped separately
					BBW Surface-mounted back box[3]

Options

NLTAIR2 PIR	nLIGHT AIR Wireless enabled motion/ambient sensor for 8'-15' mounting heights [5,6,7]
NLTAIR2 PIRH	nLIGHT AIR Wireless enabled motion/ambient sensor for 15'-30' mounting heights [5,6,7]
PE	Photoelectric cell, button type [8]
PER	NEMA twist-lock receptacle only (controls ordered separate) [9]
PER5	Five-wire receptacle only (controls ordered separate) [9]
PER7	Seven-wire receptacle only (controls ordered separate) [9]
PIR	Motion/Ambient Light Sensor, 8-15' mounting height [5,6]
PIR1FC3V	Motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 1fc [5,6]
PIRH	180° motion/ambient light sensor, 15-30' mounting height [5,6]
PIRH1FC3V	Motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 1fc [5,6]
SF	Single fuse (120, 277, 347V) [2]
DF	Double fuse (208, 240, 480V) [2]
DS	Dual switching [10]
DMG	0-10V dimming extend out back of housing for external control (control ordered separate) [11]
E7WH	Emergency battery backup, Non CEC compliant (7W) [7]
E7WC	Emergency battery backup, CA Title 20 Noncompliant (cold, 7W) [7,12]
E7WHR	Remote emergency battery backup, CA Title 20 Noncompliant (remote 7W) [7,13]
E20WH	Emergency battery pack 18W constant power, Certified in CA Title 20 MAEDBS [7]
E20WC	Emergency battery pack -20°C 18W constant power, Certified in CA Title 20 MAEDBS [7,12]
E23WHR	Remote emergency battery backup, CA Title 20 Noncompliant (remote 20W) [7,12,14]
LCE	Left side conduit entry [15]
RCE	Right side conduit entry [15]
BAA	Buy America(n) Act Compliant

Shipped separately

RBPW	Retrofit back plate [3]
VG	Vandal guard [15]
WG	Wire guard [15]

Finish *(required)*

DDBXD	Dark bronze
DBLXD	Black
DNAXD	Natural aluminum
DWHXD	White
DSSXD	Sandstone
DDBTXD	Textured dark bronze
DBLBXD	Textured black
DNATXD	Textured natural aluminum
DWHGXD	Textured white
DSSTXD	Textured sandstone

See Accessories and Notes on next page.

Accessories

Ordered and shipped separately.

WSTVCPBBW DDBXD U	Premium Surface - mounted back box
WSBBW DDBTXD U	Surface - mounted back box
RBPW DDBXD U	Retrofit back plate
DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V)[17]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V)[17]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V)[17]

NOTES

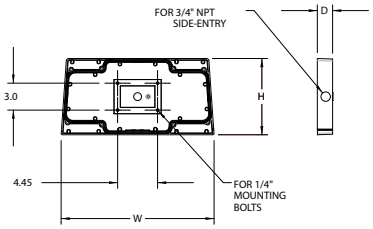
1 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
2 Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V.
3 Also available as a separate accessory; see accessories information.
4 Top conduit entry standard.
5 Not available with VG or WG. See PER Table.
6 Reference Motion Sensor table.
7 Not available with 347/480V.
8 Need to specify 120, 208, 240 or 277 voltage.
9 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. Shorting Cap included.
10 Not available with Emergency options, PE or PER options.
11 DMG option not available with standalone or networked sensors/controls.
12 Battery pack rated for -20° to 40°C.
13 Comes with PBBW.
14 Warranty period is 3-years.
15 Not available with BBW.
16 Must order with fixture; not an accessory.
17 Requires luminaire to be specified with PER, PER5 or PER7 option. See PER Table.

Optional Back Box (PBBW)

Height: 8.49″ *(21.56 cm)*

Width: 17.01″ *(43.21 cm)*

Depth: 1.70″ *(4.32 cm)*

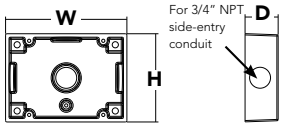


Optional Back Box (BBW)

Height: 4″ *(10.2 cm)*

Width: 5-1/2″ *(14.0 cm)*

Depth: 1-1/2″ *(3.8 cm)*



Emergency Battery Operation

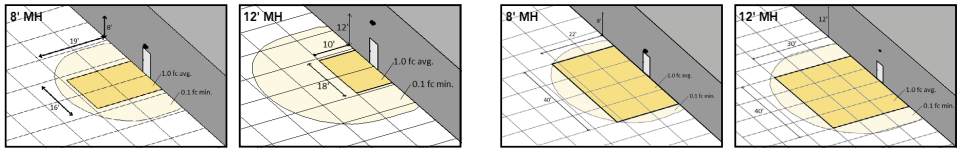
The emergency battery backup is integral to the luminaire — no external housing required! This design provides reliable emergency operation while maintaining the aesthetics of the product.

All emergency backup configurations include an independent secondary driver with an integral relay to immediately detect AC power loss, meeting interpretations of NFPA 70/NEC 2008 - 700.16

The emergency battery will power the luminaire for a minimum duration of 90 minutes (maximum duration of three hours) from the time supply power is lost, per International Building Code Section 1006 and NFPA 101 Life Safety Code Section 7.9, provided luminaires are mounted at an appropriate height and illuminate an open space with no major obstructions.

The examples below show illuminance of 1 fc average and 0.1 fc minimum of the P1 power package and VF distribution product in emergency mode.

10' x 10' Gridlines
8' and 12' Mounting Height



WST LED P1 27K VF MVOLT E7WH

WST LED P2 40K VF MVOLT E20WH

Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.03
10°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°F**	**1.00**
30°C	86°F	0.99
40°C	104°F	0.98

Projected LED Lumen Maintenance

Values calculated according to IESNA TM-21-11 methodology and valid up to 40°C.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	>0.95	>0.92	>0.87

Electrical Load

		Current (A)					
Performance package	System Watts	120	208	240	277	347	480
P1	11	0.1	0.06	0.05	0.04	---	---
	14	---	---	---	---	0.04	0.03
P1 DS	14	0.12	0.07	0.06	0.06	---	---
P2	25	0.21	0.13	0.11	0.1	---	---
	30	---	---	---	---	0.09	0.06
P2 DS	25	0.21	0.13	0.11	0.1	---	---
P3	50	0.42	0.24	0.21	0.19	---	---
	56	---	---	---	---	0.16	0.12
P3 DS	52	0.43	0.26	0.23	0.21	---	---

Motion Sensor Default Settings

Option	Dimmed State	High Level (when triggered)	Photocell Operation	Ramp-up Time	Dwell Time	Ramp-down Time
*PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	3 sec	5 min	5 min
PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	3 sec	5 min	5 min

*for use with site wide Dusk to Dawn control

PER Table

Control	PER (3 wire)	PER5 (5 wire)		PER7 (7 wire)		
			Wire 4/Wire5		Wire 4/Wire5	Wire 6/Wire7
Photocontrol Only (On/Off)	✓	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM	⊘	✓	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM with Motion	⊘	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof*	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof* with Motion	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture

✓ Recommended

⊘ Will not work

⚠ Alternate

*Futureproof means: Ability to change controls in the future.

Lumen Output

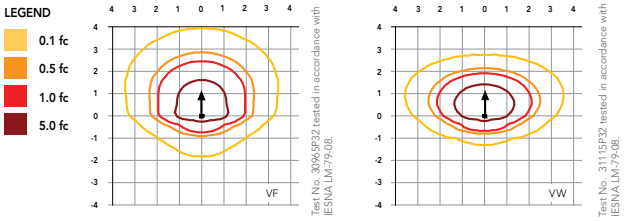
Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts.

Performance Package	System Watts (MVOLT[1])	Dist. Type	27K (2700K, 70 CRI)					30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)				
			Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P1	12W	VF	1,494	0	0	0	125	1,529	0	0	0	127	1,639	0	0	0	137	1,639	0	0	0	137
		VW	1,513	0	0	0	126	1,548	0	0	0	129	1,659	0	0	0	138	1,660	0	0	0	138
P2	25W	VF	3,163	1	0	1	127	3,237	1	0	1	129	3,469	1	0	1	139	3,468	1	0	1	139
		VW	3,201	1	0	0	128	3,276	1	0	0	131	3,512	1	0	0	140	3,512	1	0	0	140
P3	50W	VF	6,025	1	0	1	121	6,165	1	0	1	123	6,609	1	0	1	132	6,607	1	0	1	132
		VW	6,098	1	0	1	122	6,240	1	0	1	125	6,689	1	0	1	134	6,691	1	0	1	134

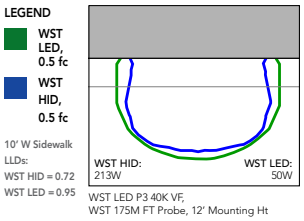
Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's WST LED homepage.

Isofootcandle plots for the WST LED P3 40K VF and VW. Distances are in units of mounting height (10').



Distribution overlay comparison to 175W metal halide.



FEATURES & SPECIFICATIONS

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A universal mounting plate with integral mounting support arms allows the fixture to hinge down for easy access while making wiring connections.

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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

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PARTNERS 21-146A
LUMINAIRE PRODUCT DATA
265700 - 150

ADA COMPLIANT | TITLE 24 | 10YR WARRANTY | UL

APPLICATIONS	Direct/Indirect grazing luminaire for exterior/interior use: flanking doors, on columns, on building facades, between windows, and elevator lobbies
SIZES	• 30″ H x 7″ W x 4″ D, 14 lbs • 45″ H x 7″ W x 4″ D, 21 lbs • 60″ H x 7″ W x 4″ D, 31 lbs • 90″ H x 7″ W x 4″ D, 42 lbs
MOUNTING	• J-Box 3.0 or 4.0 at center or end of fixture • Steel mounting system with mounting plates for facade • Vertical Mounting only
SPECIFICATIONS	• High efficiency, fully integrated propietary LED module • UL Wet Listed • 120-277V input • 100,000+ hours rated life time • 10 Year Limited Warranty (excludes shade) • Title 24 Compliant • ADA Compliant
LAMPING	• 3000K, 3500K 4000K • Tessie-30 23 watts, 729 delivered lumens • Tessie-45 29 watts, 957 delivered lumens • Tessie-60 37 watts, 1221 delivered lumens • Tessie-90 58 watts, 1914 delivered lumens • 0-10V Dimming (100-10%) • CRI: 80 min (85 Typical)
CONSTRUCTION	Fixture shell (shade): Heavy gauge aluminum with industrial powder coat finish and high impact acrylic

DIM FIXTURE DOWN TO 50% AT INSTALLATION

JUNE 13, 2023 / BIDDING - CONSTRUCTION

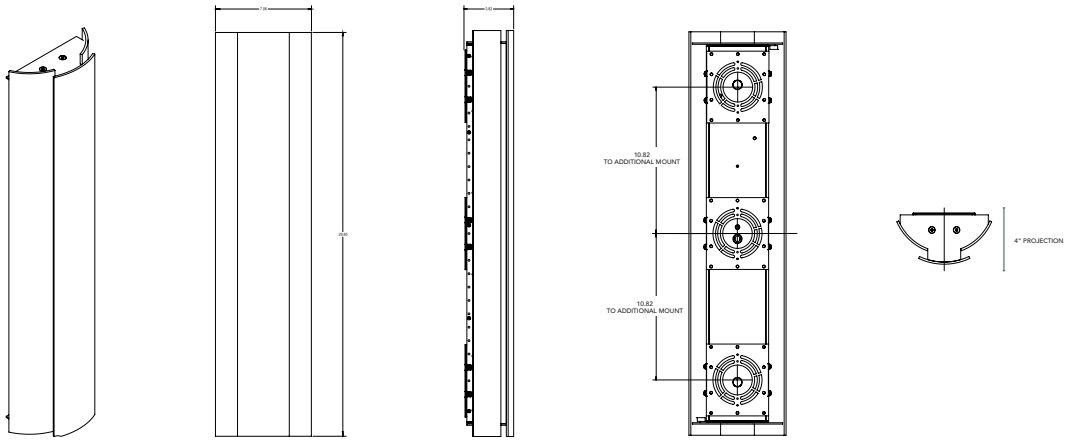
TESSIE

ARCHITECTURAL SCALE, WET-LISTED EXTERIOR WALL SCONCE

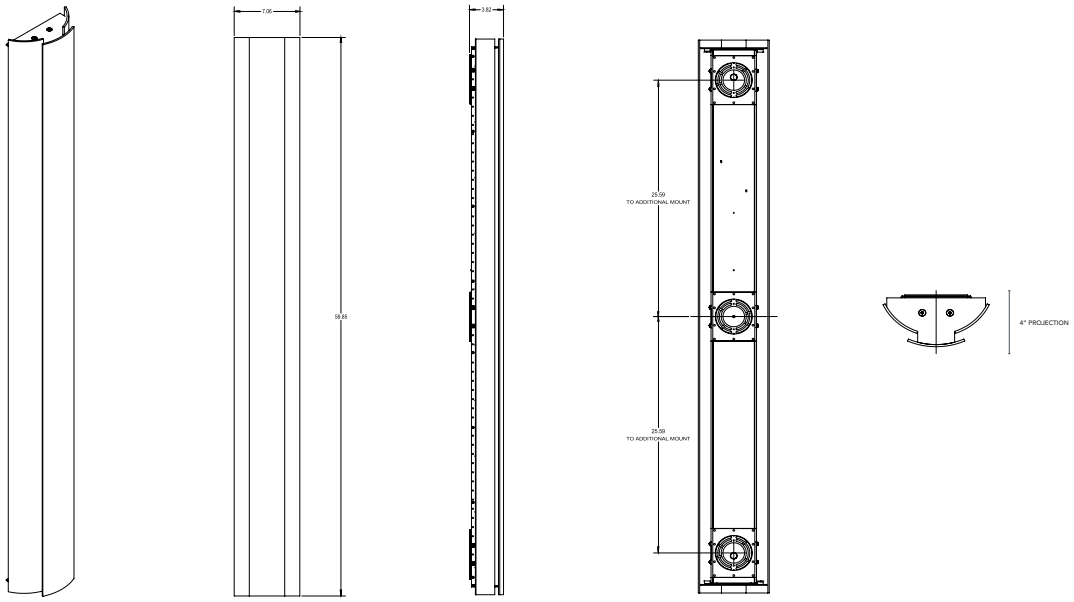
alva

DIMENSIONS

TESSIE-30



TESSIE-60



TESSIE

ARCHITECTURAL SCALE, WET-LISTED EXTERIOR WALL SCONCE

alva

METAL POWDER COAT FINISH OPTIONS


ESN - Enviro Satin Nickel


EOB - Enviro Oil-Rubbed Bronze


WHT - White


BLK - Black


GR - Graphite


DB - Dark Bronze


Tessie-30 in Enviro Satin Nickel (ESN)

ORDER CODE:

ARCHITECT TO SELECT TRIM FINISH

MODEL	LENGTH	METAL TRIM	CCT
TESSIE			

LENGTH

30	30″
45	45″
60	60″
90	90″

METAL TRIM

POWDER COAT FINISH OPTIONS

ESN	Enviro Satin Nickel
EOB	Enviro Oil-Rubbed Bronze
DB	Dark Bronze
GR	Graphite
WHT	White
BLK	Black

CCT

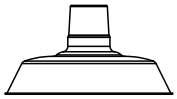
3000	3000K
3500	3500K
4000	4000K

TYPE OL7

SPS-0448 REV B

THE ORIGINAL™ INTEGRATED LED SERIES

JOB NAME: _____ FIXTURE TYPE: _____



BLE - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____

A B C D E F G H I J K L

Order Example: BLE - G - WHS16 - 600 - G22 - 980 - NA - ACR - 600 - NA - LED38 - 2700K - DL

A - MOUNTING STYLE

C	Cord Hung
CN	Chain Hung
F	Flush Mount
G	Gooseneck
S	Stem Mount

B - SHADE SIZE

THE ORIGINAL™:

WHS12[10]	**WHS20**[1]
WHS14	**WHS24**[1,2,6,10]
WHS16	**WHS28**[1,2,6,10]
WHS18	

C - SHADE FINISH

PORCELAIN FINISHES[3]:

150	Black
250	White
350	Vintage Green
355	Jadite
455	Cherry Red
550	Yellow
650	Bronze
750	Cobalt Blue
765	Delphite Blue
850	Graphite
950	Metallic Chrome

POWDER COAT FINISHES[4]:

100	Black
105	Textured Black
200	White
300	Dark Green
307	Emerald Green
311	Jadite
370	Mint
380	Chartreuse
390	Teal
400	Barn Red
420	Orange
470	Watermelon
480	Blush Pink
490	Magenta
495	Sherbet Orange
500	Buttery Yellow
570	Sunflower
600	Bronze
601	Chocolate
605	Rust
615	Oil-Rubbed Bronze
700	Royal Blue
705	Navy
710	Cobalt Blue
715	Delphite Blue

C - SHADE FINISH (CONTINUED)

POWDER COAT FINISHES[4]:

790	Lavender
800	Industrial Grey
805	Charcoal Granite
810	Graphite
975	Galvanized

NATURAL METALS[8]:

995	Raw Copper
996	Weathered Copper
997	Raw Brass
998	Weathered Brass
999	Oil-Rubbed Copper

D - MOUNTING

*Please Note: If Flush Mount [F] is selected in **Section A**, please select **NA***

NA	Not Applicable

CSA LISTED CORDS:

SBK	Standard Black
SWH	Standard White
CSB	Black Cloth
CSW	White Cloth
CMG	Grey Cloth
CSR	Red Cloth
CRZ	Red Chevron Cloth
CSBB	Black & Brown Cloth
CSRW	Red & White Cloth
CSGW	Gold & White Cloth
CSBG	Black & Gold Cloth
CSBW	Black & White Cloth
CSBP	Black & Pink Cloth
CSUW	Blue & White Cloth

CHAIN MOUNT OPTIONS:

CN36	3′ of Chain[1]
CN48	4′ of Chain[1]
CN60	5′ of Chain[1]
CN72	6′ of Chain[1]

GOOSENECK OPTIONS:

G1[1]	**G11**[1]	**G26**[1]
G2[1]	**G12**[1]	**G32**
G3[1,11]	**G13**	**G34**[1]
G4[11]	**G14**	**G35**[1]
G5[1]	**G15**	**G36**[1]
G6	**G16**[1]	**G64**[1]
G7	**G17**	**G65**[1]
G8	**G22**	
G9	**G24**	
G10	**G25**	

D - MOUNTING (CONTINUED)

STEM MOUNT OPTIONS:

ST506	.5″ Stem Mount, 6″[1]
ST512	.5″ Stem Mount, 12″[1]
ST518	.5″ Stem Mount, 18″[1]
ST524	.5″ Stem Mount, 24″[1]
ST536	.5″ Stem Mount, 36″[1]
ST548	.5″ Stem Mount, 48″[1]
ST706	.75″ Stem Mount, 6″
ST712	.75″ Stem Mount, 12″
ST718	.75″ Stem Mount, 18″
ST724	.75″ Stem Mount, 24″
ST736	.75″ Stem Mount, 36″
ST748	.75″ Stem Mount, 48″

E - MOUNTING FINISH

*Please Note: See **Section C** for Finish Options. 980-Brushed Aluminum is also available for Gooseneck and Stem mounting styles. If a Porcelain shade finish is selected, mounting will be powder coat painted-to-match. Porcelain shade finishes are not available with a Natural Metal mounting finish*
(I) If Cord Hung [C], selection identifies canopy finish
(II) If Chain Hung [CN] Mounting Style, selection identifies chain and canopy finish. Natural Metals are not applicable
(III) If Stem Mount [S] Mounting Style, selection identifies stem and canopy finish
(IV) If Flush Mount [F] Mounting Style, selection identifies hex coupler and canopy finish. Natural Metals are not applicable

980	Brushed Aluminum

F - CORDS[7]

NA	Not Applicable

*Please Note: See **Section D** for all applicable CSA Listed Cord Options*

G - SHADE ACCESSORIES

NA	None
WC	Wire Cage[1,12]
ACR	Acrylic Diffuser[5]

H - SHADE ACCESSORY FINISH

*Please Note: See **Section C** for Finish Options. Natural Metals not applicable with Acrylic Diffuser or Wire Cage. If Porcelain Finish is selected, accessory will be powder coat painted-to-match*

NA	Not Applicable

I - MOUNTING ACCESSORY

Please Note: Mounting Accessories below are only applicable with select Mounting Styles. Please refer to product listings on our website for further detail.

NA	None/Not Applicable
HSC	Hang Straight Canopy[1,9]
LDBPC	LED Decorative Backing Plate Cover[13]
LDCHX	LED Decorative Backing Plate Cover & Hex Cover[13]

J - LIGHT SOURCE

LED11	850 Lumen, 11W LED
LED16	1250 Lumen, 16W LED
LED27	2000 Lumen, 27W LED
LED38	3000 Lumen, 38W LED
LED43	4000 Lumen, 43W LED[10]

K - COLOR TEMPERATURE

2700K	2700K, Warm White
3000K	3000K, Neutral White
3500K	3500K, Bright White
4000K	4000K, Cool White

L - LED LENS

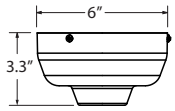
DL	Domed Lens
FL	Flat Lens

ARCHITECT TO SELECT SHADE FINISH AND GOOSENECK OPTION

IMPORTANT: *(1) Not available in Natural Metals (2) Not available in Porcelain Enamel (3) All Porcelain Enamel finished shades feature a white interior and a black outer rim (4) All Powder Coat finished shades, Galvanized excluded, feature a white interior (5) Acrylic Diffuser limits the maximum lumen selection as well as reduces lumens delivered and LPW. Selection Limits: 2000 Max for 12" and 14" shades; 3000 Max for 16" through 28" shades (6) Wire Cage not available with select size (7) Only applicable if Chain Hung Mounting Style selected in Section A, select NA if another Mounting Style is selected (8) Natural Metals have a longer estimated manufacturing time, please check the website for exact lead time. There are no returns accepted on Natural Metals (9) Only applicable if Stem Mounting Style is selected in Section A (10) Not available with Acrylic Diffuser shade accessory (11) Not compatible with 16" shade size and larger (12) Wire Cage not available for 24" & 28" shade sizes (13) Not available with G36 Gooseneck option*

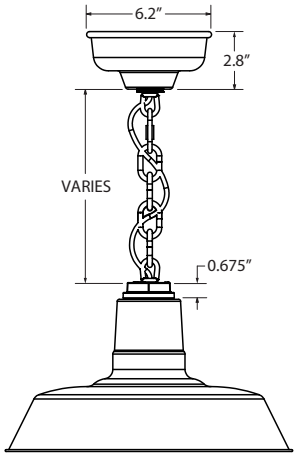
MOUNTING STYLE

HIGH LUMEN CANOPY FOR PENDANT & FLUSH MOUNT



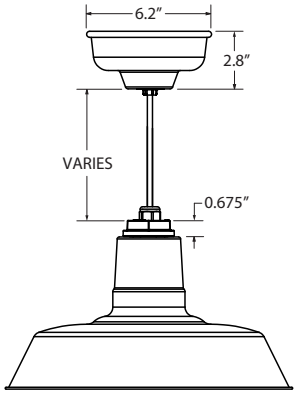
Required if LED 27, 38, 43 Light Source selected in Section J

CHAIN HUNG PENDANT (CN)



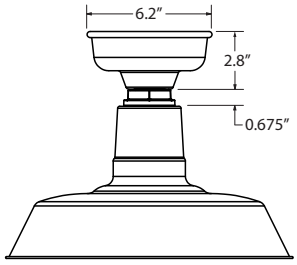
Canopy shown required if LED 11 & 16 Light Source selected in Section J

CORD HUNG PENDANT (C)



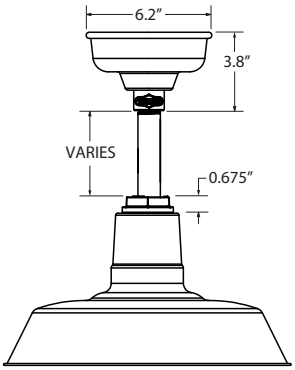
Canopy shown required if LED 11 & 16 Light Source selected in Section J

FLUSH MOUNT (F)



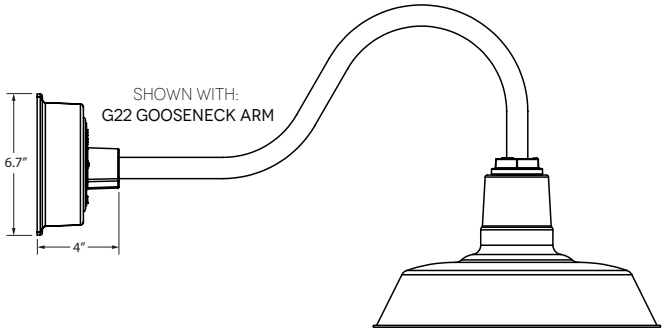
Canopy shown required if LED 11 & 16 Light Source selected in Section J

STEM MOUNT PENDANT (S)

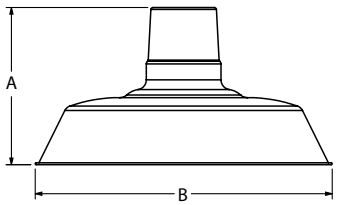


Canopy shown required if LED 11 & 16 Light Source selected in Section J

GOOSENECK (G)



LUMINAIRE DIMENSIONS



SHADE CODE	HEIGHT (A)	DIAMETER (B)
WHS12	7″	12″
WHS14	7.5″	14″
WHS16	7.75″	16″
WHS18	8.5″	18″
WHS20	9.25″	20″
WHS24	10.75″	24″
WHS28	11″	28″

LIGHT SOURCE

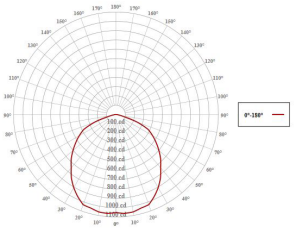
All published luminaire photometric testing performed to IESNA LM-79-08 standards by a NVLAP accredited laboratory. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. To obtain an IES file specific to your project, please contact the factory.

	LUMENS	850		1250		2000		3000		4000	
	Wattage	11		16		27		38		43	
	Optics	Lumens	LPW	Lumens	LPW	Lumens	LPW	Lumens	LPW	Lumens	LPW
WHS12	FLAT	846	74	1244	78	1997	74	2996	79	3995	93
	DOMED	824	72	1212	76	1936	72	2904	76	3872	90
WHS14	FLAT	845	74	1243	77	1982	73	2973	78	3964	92
	DOMED	823	72	1210	75	1904	71	2856	75	3808	88
WHS16	FLAT	845	74	1243	77	1982	73	2973	78	3964	92
	DOMED	822	72	1209	75	1902	70	2854	75	3805	88
WHS18	FLAT	843	74	1240	77	1978	73	2967	78	3956	92
	DOMED	819	72	1204	75	1895	70	2843	75	3791	88
WHS20	FLAT	841	74	1237	77	1973	73	2959	78	3945	91
	DOMED	815	72	1199	75	1887	70	2830	74	3773	87
WHS24	FLAT	838	74	1233	77	1968	73	2952	77	3936	91
	DOMED	810	71	1191	74	1877	70	2815	74	3753	87
WHS28	FLAT	840	74	1235	77	1974	73	2961	78	3948	92
	DOMED	811	71	1193	74	1885	70	2828	74	3771	87

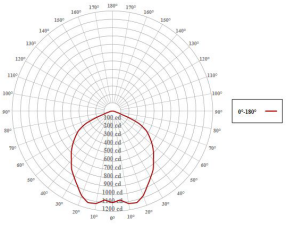
*Acrylic Diffuser option reduces lumens delivered and LPW

LIGHT DISTRIBUTION

DOMED LENS (DL)

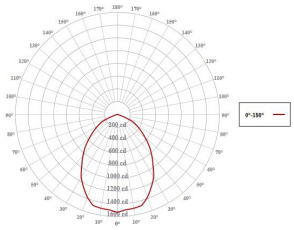


Shown above with 16" Shade (WHS16), White Interior (200-White) and 3000 Lumen (LED38)

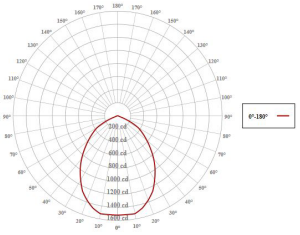


Shown above with 20" Shade (WHS20), White Interior (200-White) and 3000 Lumen (LED38)

FLAT LENS (FL)



Shown above with 16" Shade (WHS16), White Interior (200-White) and 3000 Lumen (LED38)



Shown above with 20" Shade (WHS20), White Interior (200-White) and 3000 Lumen (LED38)

SPECIFICATIONS

LED 11, 16, 27, 38, 43 LIGHT SOURCE

LED TYPE: CREE LMH2 MODULE

INITIAL LUMENS DELIVERED: UP TO 4000 LUMENS

L90(6K) > 36,300 HOURS

AVAILABLE CCT: 2700K, 3000K, 3500K, 4000K
Custom Temperatures Available upon Request

90+ CRI

2 STEP MACADAMS ELLIPSE

EFFICACY: UP TO 93 LPW
High Efficacy Available upon Request, Consult Factory for Additional Information

DIMMING

LED 11 & 16
Triac Dimming at 100-120VAC, Able to Dim down to 5%.
Dependent on Specific Dimmer.
0-10V & ELV Dimming Available upon Request.

LED 27, 38 & 43
0-10V Dimming, Able to Dim down to 10%.
Dependent on Specific Dimmer.
Triac & ELV Dimming Available upon Request.

TRIAC & ELV DIMMING AT 230 VAC
Available by Request

COMPATIBLE DIMMERS
Consult Factory for Additional Information on Dimming

LED 27, 38, 43 ELECTRICAL/LED DRIVER

DRIVER TYPE: LMD400

DRIVE CURRENT: 940mA

POWER FACTOR > 0.95

EFFICIENCY: UP TO 81% TYPICAL

INPUT VOLTAGE: 120–277 VAC (SEE DIMMING SECTION)

CLASS 2 POWER SUPPLY

LED DRIVER LIFETIME: > 50,000 HOURS (@ 25 DEG C AMBIENT)

CONDUCTED AND RADIATED EMI
Compliant with FCC CFR Title 47 Part 15 Class B (120 VAC), Class A (277 VAC) and EN55015 (CISPR 15) at 230 VAC

CERTIFICATIONS, LISTINGS & WARRANTY

MADE IN THE USA
Manufactured and Hand-Crafted in Our 60,000 Square Foot Facility Located in Titusville, FL

CSA LISTED FOR WET LOCATIONS
Includes All Gooseneck, Stem and Flush Mounting Styles

CSA LISTED FOR DAMP LOCATIONS
Includes All Chain and Select Cord Hung Mounting Styles

LIMITED WARRANTY
For Additional Information on Our Limited Warranty, Please See Our Terms & Conditions

OPERATING TEMPERATURE
-30˚C to 40˚C

LED 11, 16 ELECTRICAL/LED DRIVER

DRIVER TYPE: LMD125

DRIVE CURRENT: 440mA

POWER FACTOR > 0.9

EFFICIENCY: UP TO 81% TYPICAL

INPUT VOLTAGE: 100–120 VAC (SEE DIMMING SECTION)

CLASS 2 POWER SUPPLY

LED DRIVER LIFETIME: > 50,000 HOURS (@ 25 DEG C AMBIENT)

CONDUCTED AND RADIATED EMI
Compliant with FCC CFR Title 47 Part 15 Class B (120 VAC), Class A (277 VAC) and EN55015 (CISPR 15) at 230 VAC

SHADE & FINISHES

POWDER COAT SHADE
Hand-Spun from High Purity 0.050" Thick 3003-O Temper Aluminum

PORCELAIN SHADE
Hand-Spun from 20 Gauge Sheet Metal

POWDER COAT FINISHES
Polyester Powder Coat Finishes Are Electro-Statically Applied and Thermocured

PORCELAIN FINISHES
Applied by Hand and Fired in a High Temperature Oven

COPPER
Hand-Spun from High Purity .032 Thick C11000-O60 ETP Copper

BRASS
Hand-Spun from High Purity .050" Thick C2600-O60 Brass

MOUNTING

STEM
1/2" Nominal (0.84" Actual) or 3/4" Nominal (1.05" Actual) Sch 40, 6063 Aluminum Mounting Stem. Custom Lengths Available upon Request.

GOOSENECK
1/2" Nominal (0.84" Actual) or 3/4" Nominal (1.05" Actual) Sch 40, 6063 Aluminum Gooseneck

CORD
Cord-Hung Pendants Include 7' of Standard Cord or 5' of Cloth Cord, +/- For Socket Orientation

CHAIN
4-Gauge Chain Complete with Quick Link for On-Site Adjustments to Chain's Length

MAX FIXTURE WEIGHT
10 lbs

OL8

Wall luminaire - two-sided light distribution

BEGA

Type:
BEGA Product:
Project:
Modified:

PROVIDE SPECIFIED FIXTURE OR ENGINEER APPROVED EQUAL.

Application
Wall luminaire with light emission on two sides. Downward directed light distribution is ideal for general illumination of pathways and corridors. Upward directed light is ideal for highlighting various architectural features.

Materials
Luminaire housing constructed of die-cast marine grade, copper free (≤ 0.3% copper content) A360.0 aluminum alloy
Clear safety glass
Reflectors made of pure anodized aluminum
Silicone applied robotically to casting, plasma treated for increased adhesion
High temperature silicone gasket
Mechanically captive stainless steel fasteners

NRTL listed to North American Standards, suitable for wet locations
Protection class IP 64
Weight: 1.5 lbs

Electrical

Operating voltage	120-277V AC
Minimum start temperature	-30° C
Maximum ambient temperature	40° C
LED module wattage	3.8 W
System wattage	7.3 W
Controllability	0-10V dimmable
Color rendering index	Ra > 80
Luminaire lumens	309 lumens (4000K)
LED service life (L70)	60,000 hours

LED color temperature

☐ 4000K - Product number + **K4 (*EXPRESS*)**
☐ 3500K - Product number + **K35**
☐ 3000K - Product number + **K3 (*EXPRESS*)**
☐ 2700K - Product number + **K27**
☐ Amber - Product number + **AMB**

Wildlife friendly amber LED - Optional
Luminaire is optionally available with a narrow bandwidth, amber LED source (585-600nm) approved by the FWC. This light output is suggested for use within close proximity to sea turtle nesting and hatching habitats. Electrical and control information may vary from standard luminaire.

LED module wattage	4.2 W (Amber)
System wattage	7.6 W (Amber)
Luminaire lumens	89 lumens (Amber)

BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

Finish
All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

Available colors ☐ Black (BLK) ☐ White (WHT) ☐ RAL:
☐ Bronze (BRZ) ☐ Silver (SLV) ☐ CUS:

FINISH/COLOR AS SELECTED BY ARCHITECT.

Available Options

☐ **FSC** Fusing
☐ **FRO** Frosted lens
☐ **FFRO** Factory fixed reduced output
☐ **UPO** Uplight only

See individual accessory spec sheet for details.

Wall luminaire - two-sided light distribution

		LED	β	A	B	C
33 590	ADA	3.8 W	22°	3	5 1/8	3 7/8

β = Beam angle

BEGA 1000 BEGA Way, Carpinteria, CA 93013 (805) 684-0533 info@bega-us.com

Updated 08/07/19

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	TYPE OL9

LDN3

3" OPEN
Non-IC
New Construction Downlight

FEATURES & SPECIFICATIONS

INTENDED USE — Typical applications include corridors, lobbies, conference rooms and private offices.
CONSTRUCTION — Install from below construction standard.
Additional mounting options available including new construction mounting pan.
Ambient operating temperature: 25 °C. High ambient option available.
Light engine and driver are accessible from above or below ceiling.
Passive cooling thermal management
Max ceiling thickness 1-1/4"
OPTICS — 3 SDCM; 80 CRI typical
Diffusing lens covers optical chamber
55° cutoff to source and source image
Self-flanged anodized reflectors in specular, semi-specular, or matte diffuse finishes.
ELECTRICAL — 120V TRIAC or ELV dimming and Multi-volt 0-10V dimming available.
0-10V dimming fixture requires two (2) additional low-voltage wires to be pulled
70% lumen maintenance at 50,000 hours
LISTINGS — Certified to US and Canadian safety standards. Damp location standard (wet location, covered ceiling optional).
BUY AMERICAN — This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FARS, DFARS and DOT. Please refer to www.acuitybrands.com/buy-american for additional information.
WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/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.

Buy American

A+ Capable options indicated by this color background.

ARCHITECT TO SELECT TRIM/FINISH

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: LDN3 35/10 LO3AR LSS MVOLT UGZ

LDN3					
Series	**Color temperature**	**Lumens**	**Aperture/Trim Color**		**Finish**
LDN3 3" round	27/ 2700K	05 500 lumens	LO3 Downlight	AR Clear	LSS Semi-specular
	30/ 3000K	10 1000 lumens	LW3 Wallwash	WR[2] White	LD Matte diffuse
	35/ 3500K	15[1] 1500 lumens		BR[2] Black	LS Specular
	40/ 4000K				

Voltage	**Driver**	**Options**		
MVOLT[3] Multi-volt	UGZ10 Universal dimming to 10% (0-10V, 120V, Triac, or ELV	SF[6]	Single Fuse	HAO High ambient Option (40°C)
120 120V	UGZ Universal dimming to 1% (0-10V, 120V, Triac, or ELV	TRW[7]	White painted flange	WL Wet location
277 277V		TRBL[7]	Black painted flange	NCH New construction housing
347[4,5] 347V		NPP16D[4,5,6]	nLight network power/relay pack with 0-10V dimming.	
		NPP16DER[4,5,6]	nLight network power/relay pack with 0-10V dimming. ER controls fixtures on emergency circuit.	

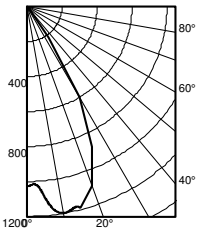
Notes
1 347V is only available with 1500lm. 1500lm not available with HAO option.
2 Not available with finishes.
3 Multi-volt 120-277V.
4 Factory supplied device shipped separately. Field installation required.
5 Access required to location of remote mounted device.
6 Must specify voltage.
7 Not required with WR and BR options.

LDN3

PHOTOMETRY

Distribution Curve	Distribution Data	Output Data	Coefficient of Utilization	Illuminance Data at 30" Above Floor for a Single Luminaire

LDN3CYL 35/10 L03AR LS, input watts: 14.31, delivered lumens: 999.8, LM/W = 69.8, spacing criterion at 0 = 1.05, test no. ISF34000SP



	Ave	Lumens
0	1026	
5	1078	108
15	1191	327
25	883	392
35	216	159
45	7	9
55	2	2
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	827.0	82.9
0° - 40°	986.0	98.8
0° - 60°	997.1	99.9
0° - 90°	997.9	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°	997.9	*100.0

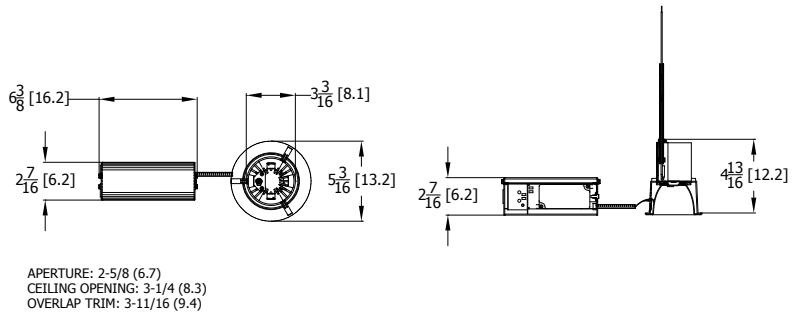
*Efficiency

pf	20%								
pc	80%			70%			50%		
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	109	107	109	107	105	105	103	102
2	104	101	97	103	99	96	99	97	94
3	98	93	90	97	92	89	94	90	88
4	92	87	83	91	86	83	89	85	82
5	87	81	77	86	81	77	84	80	76
6	82	76	72	81	76	72	80	75	72
7	77	72	68	77	72	68	76	71	67
8	73	68	64	73	68	64	72	67	64
9	70	64	60	69	64	60	68	63	60
10	66	61	57	66	60	57	65	60	57

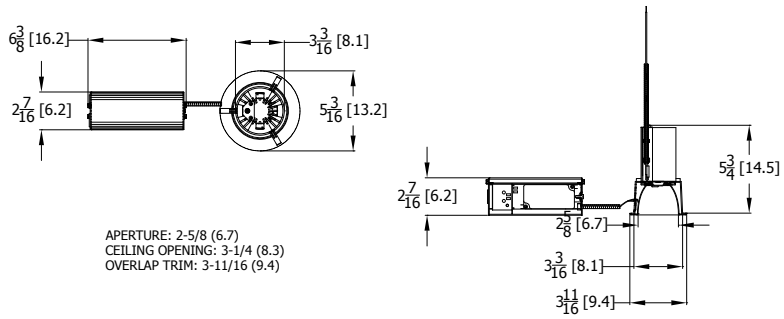
		50% beam - 55.2°		10% beam - 71.3°	
Mounting Height	Inital FC Center Beam	Diameter	FC	Diameter	FC
8.0	33.9	5.7	17.0	7.9	3.4
10.0	18.2	7.8	9.1	10.8	1.8
12.0	11.4	9.9	5.7	13.6	1.1
14.0	7.8	12.0	3.9	16.5	0.8
16.0	5.6	14.1	2.8	19.4	0.6

WATTAGE CONSUMPTION MATRIX			
Nominal Lumens	**Delivered Lumens***	**Wattage**	**Lumens per WATT**
500	530	6.27	84.5
1000	1032	14.3	72.2
1500	1491	24.9	60.0
*3500K Clear LS reflector			

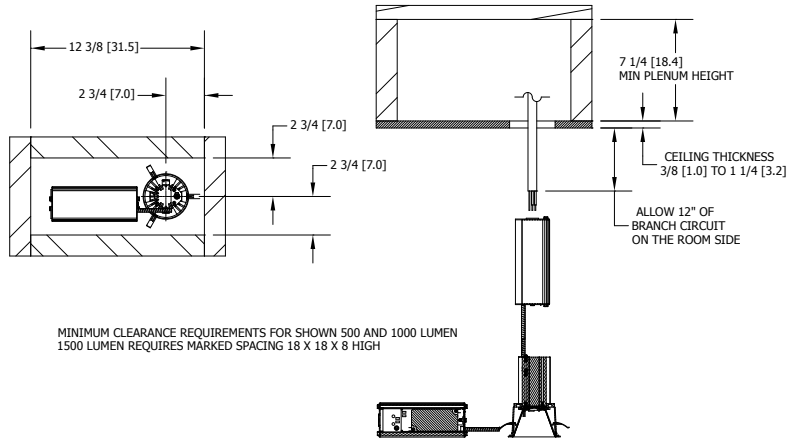
LDN3



APERTURE: 2-5/8 (6.7)
CEILING OPENING: 3-1/4 (8.3)
OVERLAP TRIM: 3-11/16 (9.4)



APERTURE: 2-5/8 (6.7)
CEILING OPENING: 3-1/4 (8.3)
OVERLAP TRIM: 3-11/16 (9.4)



MINIMUM CLEARANCE REQUIREMENTS FOR SHOWN 500 AND 1000 LUMEN
1500 LUMEN REQUIRES MARKED SPACING 18 X 18 X 8 HIGH

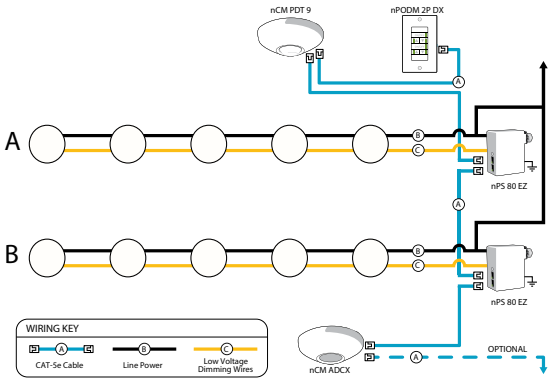
Notes

- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.
- CRI: 80 typical.

LDN3

ADDITIONAL DATA

COMPATIBLE 0-10V AND LINE VOLTAGE DIMMERS		
MANUFACTURER	PART NO.	CONTOL DEVICE DIM CURVE
Synergy®	ISD 400 ELV 120	Logarithmic
	ISD 600 I 120	Logarithmic
	ISD 1000 I 120	Logarithmic
Leviton®	IllumaTech-IPE04	Logarithmic
	IllumaTech-IPI06	Logarithmic
	IllumaTech-IPI10	Logarithmic
	IllumaTech- IPL06-10	Logarithmic
	Sureslide 6633-P 600-watt 3-way	Linear
	Sureslide 6674-P 600-watt single pole	Linear
	Sureslide 6674-P 600-watt 3-way	Linear



nLight® Control Accessories:
Order as separate catalog number. Visit www.sensorswitch.com/nLight for complete listing of nLight controls.

WallPod stations	**Model number**	**Occupancy sensors**	**Model number**
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 / nCM PDT 9
On/Off & Raise/Lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM 10 / nCM PDT 10
Graphic Touchscreen	nPOD GFX [color]	Wide view (PIR / dual tech)	nWV 16 / nWV PDT 16
Photocell controls	**Model number**	Wall Switch w/ Raise/Lower (PIR / dual tech)	nWSX LV DX / nWSX PDT LV DX
Dimming	nCM ADCX	**Cat-5 cables (plenum rated)**	**Model number**
		10', CAT5 10FT	CAT5 10FT J1
		15', CAT5 15FT	CAT5 15FT J1

PROVIDE SPECIFIED FIXTURE OR ENGINEER APPROVED EQUAL.

TYPE OL10

Streetworks

Catalog #		Type	
Project			
Comments		Date	
Prepared by			

DESCRIPTION

The UFLD-S Small Utility Flood luminaire combines high-efficiency optics, superior thermal management and energy efficiency in a cost-effective solution. The compact, robust design incorporates a separate driver compartment for maximum heat dissipation to insure longevity of both the fixture and the LEDs. Precision engineered optics deliver superior uniformity and excellent illumination to the targeted application. Typical applications include area lighting for security, building facade lighting, accent and signage lighting, and LED landscape lighting in both commercial and industrial applications.

SPECIFICATION FEATURES

Construction
Heavy-duty, die-cast aluminum housing, driver compartment and driver housing door. The housing, driver compartment and optical chamber are IP66 rated. Access to the driver for maintenance is achieved with a removable driver door using pan head screws. A one-piece silicone gasket seals the door to the fixture housing. Suitable for mounting within 4' (1.2m) of the ground.

Optics
The LED chamber incorporates a vacuum metalized reflector that provides high-efficiency illumination. Optics are precisely designed to shape the NEMA type 6H x 6V wide distribution, maximizing efficiency and application spacing. A 3H x 3V spot distribution is available to provide a concentrated beam distribution. Clear glass tempered lens with full circumference form-in-place silicone gasket protects the optics from damage. Offered standard in 4000K (+/- 275K) CCT and minimum 70 CRI. Optional 5700K CCT, 3000K CCT, 5000K CCT and 70 CRI are available.

Electrical
LED driver is mounted to the removable die-cast aluminum door for optimal heat sinking and ease of maintenance. 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation. Integral 3kV surge is standard. 10kV MOV surge protection is available. 0-10V dimming driver available. Button photocontrols are available in 120V and 208-277V. 3-PIN or 7-PIN photocontrol receptacle available as options. Suitable for ambient temperatures from -40°C to 40°C. Optional 50°C HA (high ambient) available. 93% lumen maintenance greater than 50,000 hours per IESNA TM-21.

Accessories
Heavy-duty steel top and side visors control glare and spill light. 1/8" thick UV stabilized vandal guard shields glass lens from impact when mounted at low levels. Easy to install wire guard features a heavy-gauge welded construction with corrosion resistant polyester powder coat finish to protect glass from projected objects.

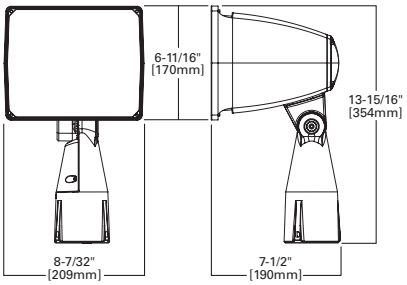
Mounting
Heavy-gauge steel trunnion-mount utilizes interlocking slide adjustment and is supplied with a 3 feet of pre-wired SOW, wet location rated cord. Trunnion base can be lag bolted to any surface and is 3G vibration rated. Heavy-duty, die-cast aluminum knuckle base utilizes tooth-lock adjustment with visual 5° adjustment indicators that allow for 180° rotation of the luminaire. Knuckle adjustment is made via the stainless steel screw. Knuckle is 1.5G vibration rated. Knuckle fits 1/2" NPS available mounting junction box cover (supplied by others) and is secured with supplied locking nut. A die-cast aluminum slipfitter with a tooth lock adjustment that can be adjusted in 5° increments is available and is 1.5G vibration rated.

Finish
Housing and cast parts finished in five-stage super TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Consult your lighting representitive at Eaton for a complete selection of standard colors.

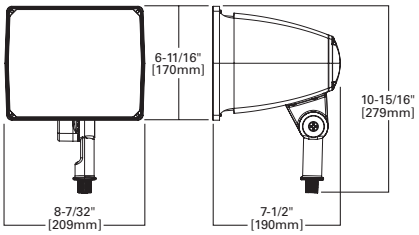
Warranty
Five-year warranty.

DIMENSIONS

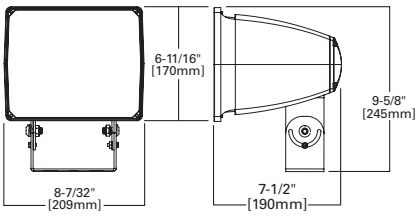
Slipfitter Mount



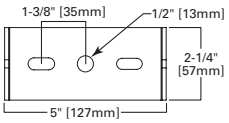
Knuckle Mount



Trunnion Mount



TRUNNION DRILLING PATTERN



Powering Business Worldwide

*www.designlights.org

UFLD-S
SMALL UTILITY FLOOD

Solid State LED

FLOODLIGHT

CERTIFICATION DATA
UL/cUL Wet Location Listed
IP66 Fixture and Optical Chamber
LM79/LM80 Compliant
3G Vibration Rated - Slipfitter Mount
3G Vibration Rated - Trunnion Mount
1.5G Vibration Rated - Knuckle Mount
RoHS Compliant
DesignLights Consortium® Qualified*

ENERGY DATA
Electronic LED Driver
> 0.9 Power Factor
< 20% Total Harmonic Distortion
120V 50/60Hz, 347V 60Hz and 480V 60Hz
-40°C Min. Ambient Temperature Rating
+40°C Max. Ambient Temperature Rating

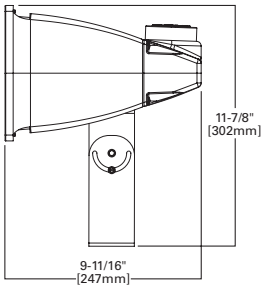
EPA
Effective Projected Area (Sq. Ft.): 0.55

SHIPPING DATA
Approximate Net Weight:
13 lbs. (6 kgs.)

TD506014EN
March 13, 2018 2:07 PM

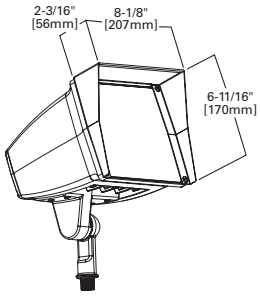
OPTION

NEMA Twistlock Photocontrol Receptacle

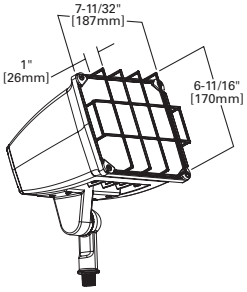


ACCESSORIES

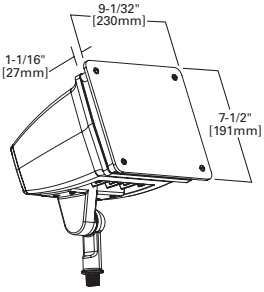
Top and Side Visors



Wire Guard



Vandal Shield



POWER AND LUMENS

Distribution	6H x 6V Wide		3H x 3V Spot	
Light Engine	**C70**	**C15**	**C70**	**C15**
Power (Watts) @ 120V	20	51	26	52
Current (A) @ 120V	0.15	0.45	0.21	0.46
Current (A) @ 277V	0.07	0.19	0.10	0.20
Current (A) @ 347V	0.06	0.16	0.10	0.21
Current (A) @ 480V	0.05	0.13	0.07	0.22
3000K Lumens	2,632	5,785	2,799	5,337
4000K Lumens	2,682	5,797	2,883	5,499
5000K Lumens	2,760	6,066	2,935	5,596
5700K Lumens	2,656	5,741	2,824	5,386

LUMEN MAINTENANCE

Distribution	Ambient Temperature	TM-21 Lumen Maintenance (50,000 Hours)	Theoretical L70 (Hours)
6H x 6V Wide	25°C	> 95.53%	> 399,000
	40°C	> 95.10%	> 362,000
	50°C	> 94.60 %	> 324,000
3H x 3V Spot	25°C	> 94.74%	> 336,000
	40°C	>93.37%	> 264,000

LUMEN MULTIPLIER

Ambient Temperature	Lumen Multiplier
10°C	1.03
15°C	1.02
25°C	1.00
40°C	0.97
50°C	0.96

FINISH/COLOR AS SELECTED BY ARCHITECT.

ORDERING INFORMATION

Sample Number: UFLD-S-C15-E-U-66-S-BZ-PC1

Product Family [1]	Light Engine [2]	Driver [3]	Voltage	Distribution	Mounting	Color
UFLD-S=Utility Flood Small	**C70**=2,700 Nominal Lumens **C15**=5,900 Nominal Lumens	**E**=Non-Dimming **D**=Dimming (0-10V) [4]	**U**=120-277V **8**=480V [5] **9**=347V	**66**=NEMA 6H x6V Wide **33**=NEMA 3H x3V Spot	**C**=Slipfitter, 2-3/8"-3" O.D. (SO cord through housing) [6] **S**=Slipfitter, 2-3/8" O.D. (Leads through slipfitter) **T**=Trunnion **KNC**=Knuckle	**BK**=Black **BZ**=Bronze **AP**=Grey **WH**=White

Options (Add as Suffix)	**Accessories** (Order Separately) [10]
4=NEMA 3-PIN Twistlock Photocontrol Receptacle [7] **4N7**=NEMA 7-PIN Twistlock Photocontrol Receptacle [4, 7] **7030**=70 CRI / 3000K [8] **7050**=70 CRI / 5000K [8] **7060**=70 CRI / 5700K [8] **HA**=50°C High Ambient Temperature [9] **D10**=<10% Dimming [4] **PC1**=Button Type Photocontrol - 120V **PC2**=Button Type Photocontrol - 208-277V **10MSP**=10kV MOV Surge Protection	**RAB-XX**=Right Angle Pipe Bracket for Slipfitter **SAB-XX**=Steel Angle Bracket for Trunnion **TYS-XX**=Slipfitter Adapter for 2-3/8", 3" or 3-1/2" O.D. Tenon [11] **TS2LW/NFFLD-XX**=Top and Side Visors [11] **VSLW/NFFLD**=Vandal Shield [12] **WGLW/NFFLD**=Wire Guard [12] **LLPC**=Long-life Photocontrol **LLPC-FO**=Long-life Photocontrol (Fail-Off)

NOTES:

1. DesignLights Consortium® Qualified and classified for both DLC Standard and DLC Premium, refer to www.designlights.org for details.
2. Standard 4000K CCT and minimum 70 CRI. Consult IES file for actual lumen output.
3. Consult factory for driver surge protection values.
4. Must order dimming driver and 7-PIN Photocontrol Receptacle together.
5. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
6. "C" mounting must utilize "4" or "4N7" Photocontrol Receptacle option.
7. Mounted on back box (included). SOE drawing previous page.
8. Extended lead times apply. Use dedicated IES files for 3000K, 5000K and 5700K when performing layouts. These files are published on the UFLD-S luminaire product page on the website.
9. HA option not available with 33 spot distribution.
10. Replace XX with color designation. Additional brackets and adaptors available on the poles product page on the website.
11. Not available with slipfitter mount.
12. Cannot combine TS2LW (Top and Side Visor), VSLW (Vandal Shield), or WGLW (Wire Guard), limited to one external guard per fixture.

MARK
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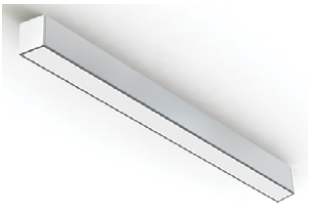


Slot 2 LED
Surface Mount

OL11

The Slot LED family of luminaires offers an unparalleled package of performance and features for your next lighting project. Precision lumen DIRECTIR optics deliver optimized light where needed for ceilings and walls. With other key features such as simplified installation, seamless controls integration and superior color constancy, the Slot LED family from Mark Lighting offers exceptional quality and design flexibility.

Type:

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 2.5" x 3.75" extruded aluminum housing

Finish
White, Black or Silver powdercoat

Reflector
Formed steel with high reflectance white

Distribution/Shielding
Extruded 90% transmissive acrylic lens with a textured surface providing diffuse illumination and a uniform appearance for direct lambertian distribution (No Optics). Wall Wash (WW) and Wall Graze (WG) distribution options incorporate co-extruded lenses. Shielding is available as an external blade louver for WW or WG options, or an internal blade louver in lieu of lambertian distribution diffuser.

LED Components
Linear: Nichia®- 757 series LED chips (>80 CRI)

Electrical
Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. 80% LED lumen maintenance at 60,000 hours (L80/60,000).

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. The color a variation of no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED® driver provides natural dimming with smooth, continuous and flicker-free deep dimming. Supports operation between 120VAC and 277 VAC, with low inrush current (NEMA 410) and THD < 20%. Meets FCC Title 47 C.F.R. 15 Class A or Class B requirements. Lutron high performance driver options also available.

Certification
CSA tested to UL 1598 standards, assembled in the USA. Damp location listed.

Listings
DesignLights Consortium® (DLC) Premium qualified product. Not all versions of this product may be DLC Premium qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

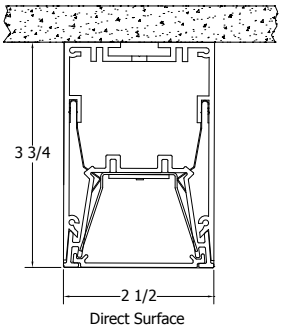
Warranty
5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

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.

Technical Drawing



PROVIDE SPECIFIED FIXTURE MARK ARCHITECTURAL LIGHTING SLOT 2 LED OR ENGINEER APPROVED EQUAL.

Fixture Performance

4FT INDIVIDUAL (35K)	DIRECT			
Lumens Output	**400LMF**	**600LMF**	**800LMF**	**1000LMF**
Delivered Lumens	1766	2710	3577	4225
Input Watts	14.4	22.5	30.6	37.1
Lumen/Watt	122	120	116	113

** Consult factory for customized lumen output and wattage between 350LMF and 1050LMF*

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

MARK ARCHITECTURAL LIGHTING™

Slot 2 LED
Surface Mount

COORDINATE LENGTHS WITH ARCHITECTURAL CANOPY DETAILS. LENGTH SHALL BE APPROXIMATELY 30FT AS INDICATED ON PLANS.

A+ Capable options indicated by this color background.

Ordering

Example: S2LS 32FT MSL8 90CRI 40K 1000LMF DARK EGLD 120 WHT ZT

Series
- **S2LS** Slot 2 Surface - Direct

Plan
- **LCB** Linear center balanced
- **LLP** Linear longest possible

Total Run Length
- **_FT** Specify continuous run length (in whole feet, 2' minimum)

Unit length may affect available options.
2' & 3' only available as individual units

For runs longer than 8FT: ALWAYS order the run by the TOTAL RUN LENGTH. Ordering the sections individually will not provide the correct joining hardware to allow connection in the field.

Max Section Length
- **MSL4** 4'
- **MSL5** 5'
- **MSL6** 6'
- **MSL7** 7'
- **MSL8** 8'

Direct Light Source Color Rendering
- **80CRI** 80 CRI
- **90CRI** 90 CRI

Direct LED Color Temp
- **27K** 2700K
- **30K** 3000K
- **35K** 3500K
- **40K** 4000K
- **50K** 5000K

Direct LED Light Output
- **400LMF** 400 lumens per FT
- **600LMF** 600 lumens per FT
- **800LMF** 800 lumens per FT
- **1000LMF** 1000 lumens per FT
- **_LMF**[1] # lumens per FT

Direct Distribution (Optics)
- **(blank)** Standard lambertian distribution
- **WW** Wallwash distributions
- **WG** Wall graze distribution

WW and WG not available with Downlights, EGLD, LVRR or LVRRA.

Downlight
- **(blank)** No Downlight modules in fixture
- **2DL** LED downlights (2 per unit)
- **_DL** LED downlights per run (3DL, 4DL, etc.)

Must select all Downlight options.
Specify number of downlights modules.
Not available on 2' or 3' units.
Not available with 347V.
Maximum of 2DL in 4' & 5' units.

Downlight Shape
- **(blank)** No downlight modules in fixture
- **RDD** Round
- **SQD** Square

Maximum of 3DL in 6', 7' & 8' units.
Not available with emergency options.
Not available with 4' unit with DCT.
Not available with any sensors on the same unit.

Downlight Color Rendering
- **(blank)** No downlight modules in fixture
- **S80CRI** 80 CRI

Downlight Color Temp
- **(blank)** No downlight modules in fixture
- **S27K** 2700K
- **S30K** 3000K
- **S35K** 3500K
- **S40K** 4000K

Minimum Dimming Level
- **NODIM**[2] Non-dimming
- **MIN1** Constant current, dimming to 1%
- **DARK** Constant current, dimming to 0.1%

DIM FIXTURE DOWN TO 50% AT INSTALLATION

Optional Shielding
- **(blank)** No louver
- **LVRD**[3] Dropped louver
- **LVRR**[5] Regressed louver painted to match fixture finish
- **LVRRA**[5] Regressed louver, aluminum finish
- **EGLD**[3,4] Edge View direct lens

Not available with Downlights.
Not available with DMX.

Voltage
- **MVOLT** Multi-volt, 120-277V
- **120** 120V
- **277** 277V
- **347**[6] 347V

Finish
- **WHT** White (gloss)
- **BLK** Black (gloss)
- **SLV** Silver (gloss)
- **WHTT** White (textured)
- **BLKT** Black (textured)
- **SLVT** Silver (textured)
- **RALTBD** RAL paint finishes

Emergency Options
- **E10WLCP**[7] 4' emergency section w/ battery pack, 1250 lumens
- **_E10WLCP**[7] 4' emergency section w/ battery pack, 1250 lumens
- **_EC**[8] # of emergency circuits
- **BGTD**[9] Generator transfer device

Not available with 347V.

Control Input
- **(blank)** Non-dimming, line voltage
- **ZT** 0-10V control
- **NLIGHT**[10] nLight enabled
- **NLTAIR2**[16] nLight Air Wireless Enabled
- **DALI**[11] DALI compatible
- **DMX**[11,12] DMX compatible
- **ECOD**[12,13] Lutron Hi-Lume digital driver
- **ECOD2**[12,13,14] Lutron Hi-Lume 2-wire (1% dimming)
- **ECOD5**[12,13] Lutron 5-series digital driver (5% dimming)

Sensor
- **(blank)** Select if single zone/no zone without sensor
- **NS** Select if multi-zone fixture with no sensor in main zone
- **PDT_**[15] Occupancy sensor - dual technology (passive infrared & microphonics)
- **ADC_**[15] Photocell-daylight dimming sensor
- **API_**[15] PIR occupancy sensor & photocell
- **APD_**[15] PDT occupancy sensor & photocell

Not available with Downlights.
Not available with 347V & nLight. (Use ZT Control Inputs where applicable.)
Not available on 2' or 3' units.

NO SENSOR

Secondary Sensor
- **(blank)** No additional zones/sensors
- **SNS** Select if multi-zone fixture with no sensor in secondary zone
- **SPDT_**[15] Occupancy sensor - dual technology (passive infrared & microphonics)
- **SADC_**[15] Photocell-daylight dimming sensor
- **SAPI_**[15] PIR occupancy sensor & photocell
- **SAPD_**[15] PDT occupancy sensor & photocell

Not available with Downlights.
Not available with 347V & nLight. (Use ZT Control Inputs where applicable.)
Not available on 2' or 3' units.

NO SENSOR

Tertiary Sensor
- **(blank)** No additional zones/sensors
- **TNS** Select if multi-zone fixture with no sensor in tertiary zone

NO SENSOR

Options
- **GLR**[12] Fast-blow fuse
- **GMF**[12] Slow-blow fuse
- **WL**[12] Wet Location
- **DPL** Damp Location
- **USPOM** US point of assembly

FINISH AND COLOR AS SELECTED BY ARCHITECT.

Notes:
1. Limited to 400LMF to 1000LMF in 50LMF increments. Not available with ECOD, ECOD2, ECOD5 or DMX control input.
2. Not available with Control Input.
3. Not available with Sensor Options.
4. Not available with Emergency Options
5. Not available with sensors on 2', 3' & 4' units.
6. Not available with ZT & sensors, with emergency options, with NLIGHT in 5' units, with NLIGHT & downlights.
7. Not available with 2' or 3' units. Not available with DMX control option. One battery pack per unit. Only available on 8' unit with ECOD, ECOD2, ECOD5. If with ZT & API or APD, only available in 7' & 8' units.
8. Powers entire direct unit. Not available with DMX.
9. Must select 120 or 277 volt. Remote mounted. Not available with sensor and BGTD in same unit. Not available with DMX.
10. Comes with white CAT5 cord in addition to the standard power cord. Will require remote mounted nIO on 2' unit. One nLight device per zone or sensor, for multiple zones consult factory.
11. Must select DARK Dim Level.
12. Not available with 347V.
13. Must select MIN1 Dim Level. Not available on 2', 3' or 5' units.
14. 120V only.
15. Requires ZT or NLIGHT Control Input.
16. Must select MIN1 or DARK Dim Level. Not available with 347, WW, 2' or 3' units. Not available with WL. If ordered with E10WLCP, only available in 7' & 8' units. One NLTAIR2 device per zone or sensor, for multiple zones consult factory. For antenna location, see page 5.

MARK
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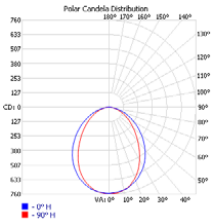
Slot 2 LED
Surface Mount

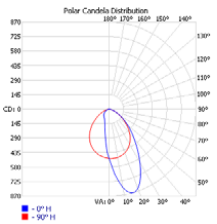
PHOTOMETRICS



Test Report: ISF 37224P0
IES LM 79-08
S2LD 4FT 80CRI 30K 400LMF
Lumens: 1697
Wattage: 14.44
Efficacy: 117.5

Zonal Lumen Summary		
Zone	Lumens	% Luminaire
0-30	559.6	33%
0-40	879	51.80%
0-60	1415.1	83.40%
60-90	281.4	16.60%
70-100	115.5	6.80%
90-120	0.3	0%
0-90	1696.6	100%
90-180	0.4	0%
0-180	1697	100%

Angle	Candlepower Distribution Plane								
	0	22.5	45	67.5	90	112.5	135	157.5	180
0	753	753	753	753	753	753	753	753	753
5	745	748	749	749	753	749	751	751	747
10	734	739	737	735	735	736	740	742	738
15	712	714	710	705	708	706	711	721	718
20	684	685	676	662	662	663	677	689	689
25	643	642	627	606	603	610	630	649	653
30	601	596	574	544	535	545	575	602	609
35	548	539	510	475	462	474	512	548	557
40	490	479	443	408	393	406	447	488	500
45	428	416	379	339	328	344	384	427	438
50	366	354	314	282	271	284	322	363	378
55	308	295	257	231	223	233	263	303	314
60	248	236	205	183	177	187	212	244	256
65	193	184	161	142	137	143	163	190	201
70	143	133	117	105	102	107	122	141	151
75	96	89	78	72	69	73	84	95	101
80	53	51	46	41	41	44	49	55	59
85	20	19	19	19	19	20	22	24	24
90	0	0	1	1	1	2	2	2	2



Test Report: ISF 37225P0
IES LM 79-08
S2LD 4FT 80CRI 30K 400LMF WW
Lumens: 1047
Wattage: 14.5
Efficacy: 72.2

Zonal Lumen Summary		
Zone	Lumens	% Luminaire
0-30	390.8	37.30%
0-40	605.7	57.90%
0-60	921.1	88%
60-90	119.6	11.40%
70-100	44.5	4.20%
90-120	3.1	0.30%
0-90	1040.7	99.40%
90-180	6.3	0.60%
0-180	1047	100%

Angle	Candlepower Distribution Plane								
	0	22.5	45	67.5	90	112.5	135	157.5	180
0	493	493	493	493	493	493	493	493	493
5	652	637	603	558	493	443	391	362	353
10	796	773	715	619	490	378	296	250	236
15	866	853	791	666	479	321	222	178	164
20	843	843	818	693	464	270	172	136	128
25	745	766	792	697	439	225	138	114	108
30	620	645	718	672	408	191	116	100	97
35	499	525	616	614	367	161	101	90	89
40	392	420	506	538	322	136	90	83	81
45	311	331	400	448	270	114	79	73	73
50	241	255	314	353	217	96	69	65	64
55	177	191	238	265	166	79	58	54	54
60	126	136	171	191	123	61	47	43	43
65	85	91	117	131	86	47	36	34	33
70	57	60	76	84	56	34	26	24	24
75	36	38	45	50	35	22	17	16	16
80	20	20	23	25	19	11	9	9	9
85	8	8	8	8	7	5	4	4	5
90	1	1	0	0	0	0	0	1	1

Shielding

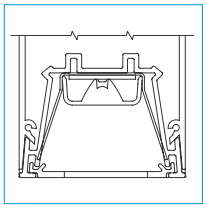

Co-Extruded WG

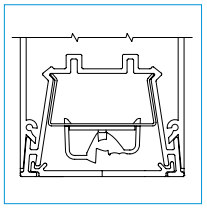

Co-Extruded WW

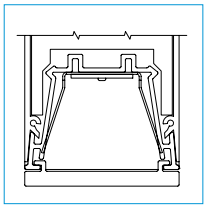

Edge View Lens

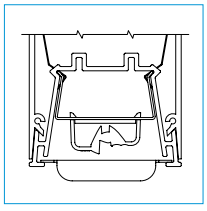

External Louver

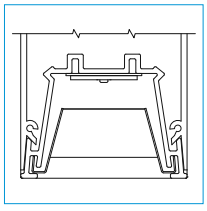

Regressed Louver


Co-Extruded WG (Standard)


Co-Extruded WW (Standard)


Edge View Lens (Optional)


External Louver WW (Painted to Match Housing)


Regressed Louver (Natural Aluminum or Painted to Match Housing)

MARK
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Slot 2 LED
Surface Mount

LINEAR PLAN:

Mark Lighting offers the ability to provide a continuous run plan to suit your requirements by optionally offering three different methods of configuration.

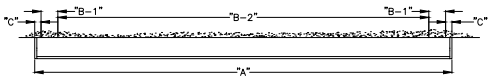
LLP- Linear Longest Possible
In this configuration, the longest length available is optimized, resulting in the fewest segments and mounting locations. Caution, should be used where balanced appearance is a concern. Example: 20 FT run would have 2, 8 FT segment and 1, 4 FT segment at the end of the run.

LLP	8 FT	8 FT	4FT

LCB- Linear Center Balanced:
This configuration incorporates the longest center segment(s) along with any additional lengths required to fill the run length, added to the run ends. Example: 16 FT run would have 2, 4 FT segments (one at each end) and 1, 8 FT segment in the center.

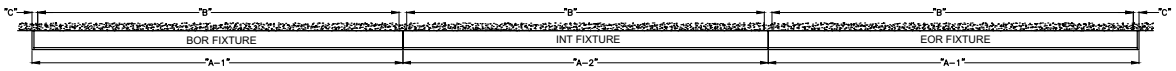
LCB	4 FT	8 FT	4FT

Individual Fixture Configurations



INDIVIDUAL UNITS (MOUNTING)				
LENGTH	"A" O.A.L.	"B-1" O.C.	"B-2" O.C.	"C" FROM END
2FT	2'- 5/8"	2"	1'-7"	13/16"
3FT	3'- 5/8"	2"	2'-7"	13/16"
4FT	4'- 5/8"	2"	3'-7"	13/16"
5FT	5'- 5/8"	2"	4'-7"	13/16"
6FT	6'- 5/8"	2"	5-7"	13/16"
7FT	7'- 5/8"	2"	6'-7"	13/16"
8FT	8'- 5/8"	2"	7'-7"	13/16"

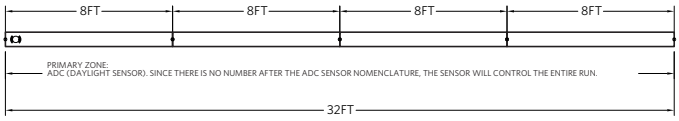
Run Configurations



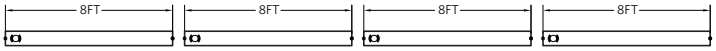
RUN LAYOUT (MOUNTING)				
LENGTH	"A-1" O.A.L.	"A-2" O.A.L.	"B" O.C.	"C" FROM END
4FT	4'-0 5/16"	4'-0"	3'-11"	13/16"
5FT	5'-0 5/16"	5'-0"	4'-11"	13/16"
6FT	6'-0 5/16"	6'-0"	5-11"	13/16"
7FT	7'-0 5/16"	7'-0"	6'-11"	13/16"
8FT	8'-0 5/16"	8'-0"	7'-11"	13/16"

TOTAL RUN LENGTH

This system is not modular. Runs longer that 8FT will be automatically configured with Starter, Middle and Ender sections, based on how you specify the TOTAL RUN LENGTH and MAXIMUM SECTION LENGTH parameters in the ordering information. Always order the total run length, not the individual sections



Example: This run must be ordered as 1pc "S2LS LLP 32FT MSL8..."



Example: If you order as 4pcs "S2LS LLP 8FT MSL8... you will receive these INDIVIDUAL sections that cannot be joined together

MAXIMUM SECTION LENGTH

The run will be broken out using as many sections at the chosen MSL length as possible. Shorter sections will then complete the desired run length.

Examples:
S2LS LLP 21FT MSL5... = 5FT / 4FT / 4FT / 4FT / 4FT
S2LS LLP 21FT MSL6... = 6FT / 6FT / 5FT / 4FT
S2LS LLP 21FT MSL7... = 7FT / 7FT / 7FT
S2LS LLP 21FT MSL8... = 8FT / 8FT / 5FT

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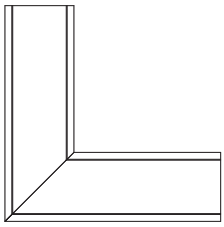
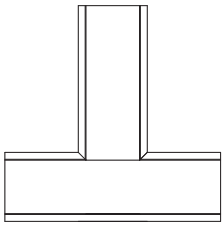
Slot 2 LED
Surface Mount

Run Patterns, Corners and Junction

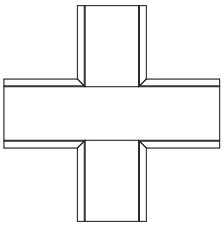
Slot 2 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.
See separate patterns spec sheet for more details.



90° Corner



T Junction

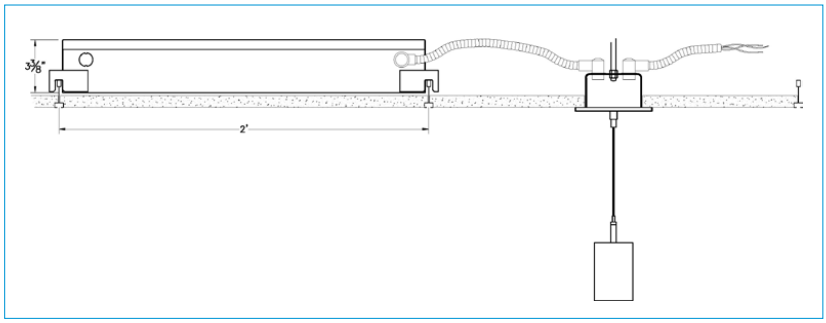


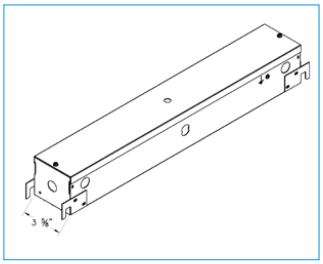
X Junction

Remote BGTD Mounting Option

Recessed in sheetrock ceiling; rod mounted to structure. Consult factory for other ceiling types or canopy options.

6 foot flexible conduit included, BGTD option should be mounted within 6 feet of junction box above fixture.

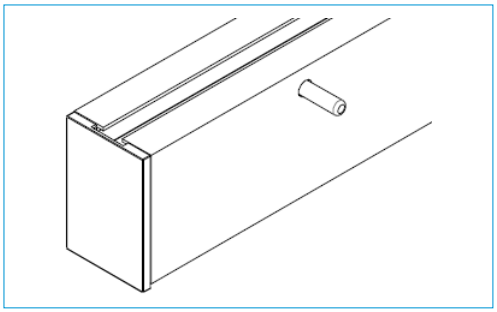




Accessible Ceiling

nLight Air Wireless Antenna Location

Note: Antenna will be shipped separately and will need to be attached to the coax connector.



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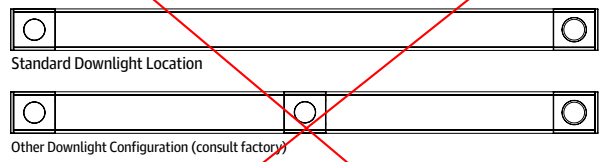
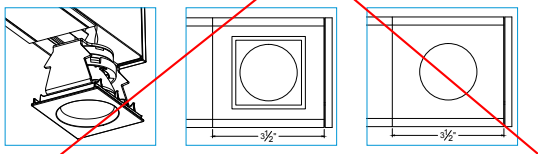
Slot 2 LED
Surface Mount

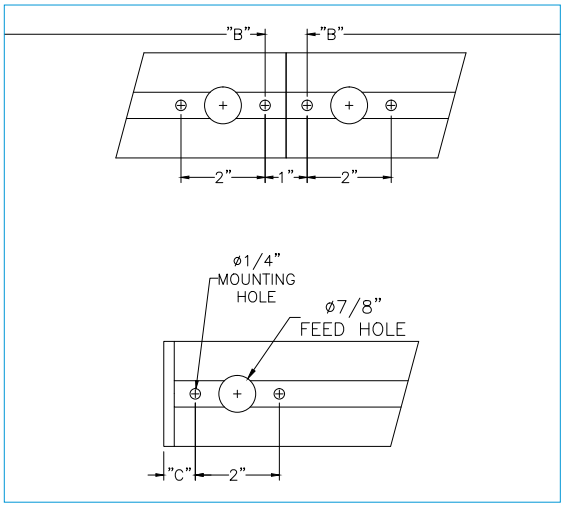
Downlights
Optional downlights powered by Xicato Spot Modules are available with 4', 5', 6', and 8' length luminaires, maximum (2) Xicato downlights per length. Each downlight module is 10W with 700 lumens delivered, 28 degree beam spread. Downlights are supplied with a dedicated feed point and will be controlled separately.





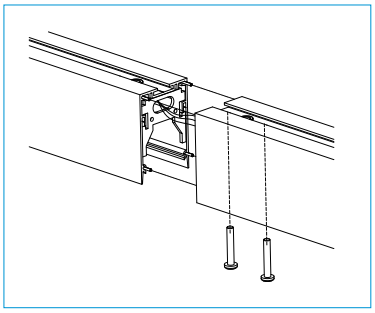
Downlight Module | Square Downlight Plate (SQ) | Round Downlight Plate (RD)

Mounting

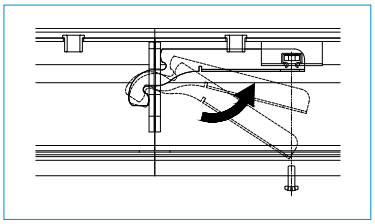


Our surface product mounts to hard/sheetrock ceilings only. Consult manufacturing for use with a grid ceiling.

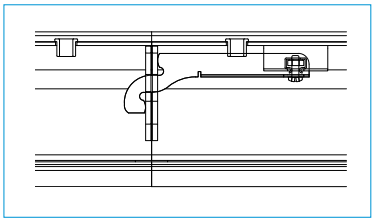
Joiners
AEL Precision Row-Mount 3-step fixture-to-fixture connection method



Step 1: Align



Step 2: Engage



Step 3: Lock

Continuous Runs

Slot 2 LED continuous rows can be configured in 1' increments and featuring the AEL precision joiner to create a hairline seam between luminaires, providing a monolithic visual aesthetic. For custom run lengths less than a 1' increment, consult factory.

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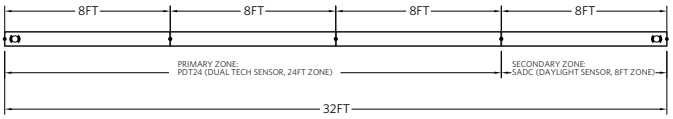
Slot 2 LED
Surface Mount

INTEGRATED SENSOR LAYOUT

For runs longer than 8FT:
ALWAYS order the run by the TOTAL RUN LENGTH. Ordering the sections individually will not provide the correct joining hardware to allow connection in the field.

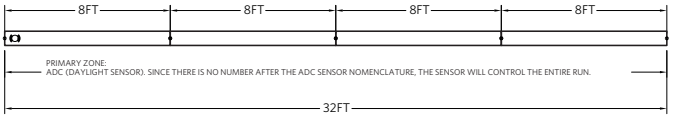
CORRECT:

32FT MSL8 RUN WITH 2 SENSORS WITH PRIMARY ZONE 24FT AND SECONDARY ZONE 8FT -- PDT24 SADC8



Total Run Length to Order

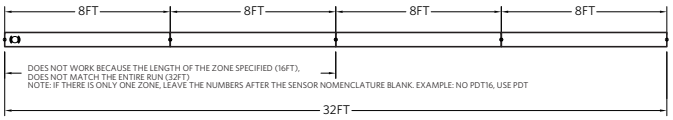
32FT MSL8 RUN WITH 1 SENSOR ALL ONE ZONE -- ADC



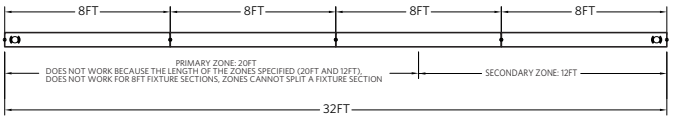
Total Run Length to Order

INCORRECT:

32FT MSL8 RUN WITH 1 SENSOR ALL ONE ZONE -- PDT16



32FT MSL8 RUN WITH 2 SENSORS WITH PRIMARY ZONE 20FT AND SECONDARY ZONE 12FT -- PDT20 SADC12



Notes:
- Only one sensor per zone
- At the most, the entire run can only have 2 sensors (thus 2 sensors zones at the most)
- Sensor zone can not split fixture sections
- No overlapping zones

OCCUPANCY DETECTION COVERAGE

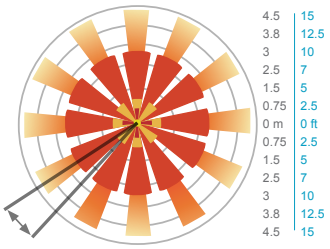
At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

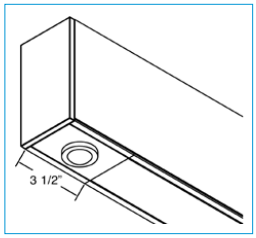
Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.

Lens rotates 15° to enable adjustment



Integrated Controls
Optional nLight® integrated controls make Slot LED luminaires addressable- allowing them to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling.



Occupancy Sensor and/or Photocell

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Slot 2 LED
Surface Mount

Intelligent Luminaire Technology Guide

Driver Configurations

Choose nomenclature from these columns

Minimum Dimming Level		Control Input		Driver	Dimming Range	Notes
NODIM	+	(blank)	=	0 10V Generic Driver	-	Includes no 0 10V leads from the driver.
MIN10	+	ZT	=	0 10V Generic Driver	100 to 10%	Linear dimming
MIN1	+	ZT	=	0 10V eldoLED ECOdrive	100 to 1%	Formerly (EZ1) nomenclature. Linear dimming
MIN1	+	NLIGHT	=	0 10V eldoLED ECOdrive	100 to 1%	Logarithmic dimming
MIN1	+	ECOD2	=	Lutron forward phase control	100 to 1%	LUTRON Hi-lume 1% 2-wire (model LTEA4U1U)
MIN1	+	ECOD5	=	Lutron Ecosystem	100 to 5%	LUTRON 5 Seires EcoSystem LED Driver (model LDE5)
MIN1		ECOD		Lutron Ecosystem	100 to 1%	LUTRON Hi-lume 1% EcoSystem LED Driver with Soft-on, Fade-to-Black (model LDE1)
DARK		ZT		0 10V eldoLED SOLOdrive	100 to 0.1%	Formerly (EZB) nomenclature. Linear dimming
DARK		NLIGHT		0 10V eldoLED SOLOdrive	100 to 0.1%	Logarithmic dimming
DARK		DALI		DALI compatible eldoLED SOLOdrive	100 to 0.1%	"Compatible with DALI. Formerly (EDB & EDAB) nomenclature." Logarithmic dimming
DARK		DMX		DMX compatible eldoLED POWERdrive	100 to 0.1%	"Compatible with DMX / Remote Device Management. Formerly (EXB & EDXB) nomenclature." Linear dimming

Control / Sensor Configurations

Choose nomenclature from these columns

Control Input		Sensor		Sensor	Notes
ZT	+	API	=	MSD 7 ADCX	Individual fixture control only. PIR integral occupancy sensor with automatic dimming control photocell. (Old nomenclature: ZT + PIR + ADC)
ZT	+	APD	=	MSD PDT 7 ADCX	Individual fixture control only. PDT integral occupancy sensor with automatic dimming control photocell. (Old nomenclature: ZT + PDT + ADC)
NLIGHT	+	(blank)	=	nIO EZ PH	nLight enabled only. No onboard sensor.
NLIGHT		EMG	=	nIO EZ PH ER	Emergency nLight enabled only. No onboard sensor.
NLIGHT	+	API	=	nIO EZ PH + nES 7 ADCX	nLight nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell. (Old nomenclature: NLIGHT + PIR + ADC)
NLIGHT	+	PDT	=	nIO EZ PH + nES PDT 7	nLight nES PDT 7 dual technology integral occupancy sensor. (Old nomenclature: NLIGHT + PDT)
NLIGHT	+	APD	=	nIO EZ PH + nES PDT 7 ADCX	nLight nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell. (Old nomenclature: NLIGHT + PDT + ADC)
NLTAIR2		(blank)		RIO EZDL 90D G2	https://www.acuitybrands.com/products/detail/778845/nLight/rIO/Fixture-embedded-nLight-AIR-network-interface
NLTAIR2		API		RES7 G2	https://www.acuitybrands.com/products/detail/593899/nLight/RES7 Sensor/nLight-AIR Fixture-Integrated-Wireless-Sensor
NLTAIR2		APD		RES7 PDT G2	https://www.acuitybrands.com/products/detail/593899/nLight/RES7 Sensor/nLight-AIR Fixture-Integrated-Wireless-Sensor

LITHONIA LIGHTING®

Catalog Number	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER APPROVED EQUAL.
Notes	
Type	X1

PRECISE® COLLECTION

Edge-Lit Exits

LRP

LED LAMPS

Approved Alternate Manufacturers:
Dual Lite LE Series & Sure Lites ELX Series

NEMA Premium

LED

FEATURES & SPECIFICATIONS

INTENDED USE — Suitable for architectural applications where aesthetics and superior performance are required.

CONSTRUCTION — High-polish, injection-molded virgin acrylic panel, ultrasonically welded to eliminate visible hardware. Graduated depth of molded letters provides uniform light distribution on graphics. Standard housing finish is brushed aluminum.

Precision-molded, textured letters – 6" high with 3/4" stroke, with 100 ft viewing distance rating, based upon UL924 standard. Chevron indicator direction must be specified.

Recessed rough-in section constructed of 20-gauge, die-formed galvanized steel. Extruded aluminum housing trim mounts flush onto wall or ceiling.

Mounting canopy for top mount is constructed of extruded aluminum housing to match housing finish.

ELECTRICAL — Sealed, maintenance-free nickel cadmium battery delivers 90 minutes capacity to lamp. Constant-current series charger, 24-hour recharge after 90-minute discharge.

Polarized battery connector simplifies installation and maintenance; prevents charger damage due to improper connection.

OPTICS — LEDs mounted on printed circuit board. The typical life of the exit LED lamp is 10 years.

Low energy consumption – EL N operation: only 2.3W for 120V single-face red sign; 1.7W for 120V single-face green sign. Non-emergency operation: only 1.5W for 120V single-face red sign; 1.2W for 120V single-face green sign.

INSTALLATION — Recessed mount – rough-in section for back, ceiling or end mounting. Fits into minimum wall or ceiling opening 13-5/8" L x 4-1/2" W x 3-1/8" D.

Adjustable T-bar hangers adapt mounting tray for mounting in suspended ceilings or variable-size framed openings. Trim ring has 3/4" variable depth adjustment to ensure flush fit against surface of wall or ceiling.

Plug-in wire connections and self-captive mounting screws for mounting panel/trim to rough-in section.

Top Mount (TM) - low-profile mounting canopy attaches exit to J-box. No rough-in section required.

LISTINGS — UL listed. Non-IC recessed mounting. Meets UL 924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards, and State of Minnesota requirements for less than 20W energy consumption. Listed and labeled to comply with Canadian Standards C-860 and C-22.2 No.9 (see options). NEMA Premium certified.

WARRANTY — 5-year limited warranty, including lamps. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

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.

FACE AS INDICATED ON PLANS

INDICATORS AS SHOWN ON PLAN

ORDERING INFORMATION

For shortest lead times, configure products using **bolded options.**

Example: LRP 1 RMR LA 120/277 EL N

LRP									
Family	**Housing color**		**Number of faces**		**Letters/background**		**Directional indicators**[2]		**Input voltage**	
LRP	LED	**(blank)**	Brushed aluminum	**1**	Single face	RW	Red on white	**(blank)**	None	**120/277**	Dual voltage
		W	White	**2**	Double face	**RC**	Red on clear (single face only)	**LA**	Left[3]	**120/347**	Dual voltage[5]
		B	Black			**RMR**	Red on mirror (simulates clear background for double-face exits)	**RA**	Right[3]		
		BZ	Bronze			GW	Green on white	**LRA**	Left and right		
		BS	Polished Brass[1]			**GC**	Green on clear (single face only)	**DA**	Double face[4]		
		U	Unfinished			**GMR**	Green on mirror (simulates clear background for double-face exits)				

MOUNTING AS SHOWN ON PLANS

Emergency operation		Mounting		Item type		Options[8]	
(blank)	AC only	**(blank)**	Ceiling or back mount	**(blank)**	Complete exit panel and rough-in section[6]	FI	Fire alarm interface[9,10]
EL N	Nickel cadmium battery	EM	Recessed end mount	**PNL**	Panel assembly only	F	Flashing emergency operation (one flash/second)[9,11]
X2	Lamp boards wired on two separate circuits (specify 120V or 277V)[6]	TM	Top mount[7]			FA	Flashing emergency operation and intermittent audible alarm
						CSA	Listed and labeled to comply with Canadian standards[11]

Accessories[8,12]**:** *Order as separate items.*

ELA R LRIS 120/277 EL N	Single-face, red LED emergency rough-in section
ELA G LRIS 120/277 EL N	Single-face, green LED emergency rough-in section
ELA R 2LRIS 120/277 EL N	Double-face, red LED emergency rough-in section
ELA G 2LRIS 120/277 EL N	Double-face, green LED emergency rough-in section
ELA LCRIS	LED rough-in section (supplied standard with recessed exit unless PNL suffix is specified; order ELA LCRIS only if needed for early installation). Available AC only with no options.[9]
ELA US12	12" pendant-mount kit (Top mount exits only). Mounting canopy is brushed aluminum. To order white or black canopy, add W or B to catalog number. Example: ELA W US12. To order 24" or 36" lengths, add 24 or 36 to catalog number. Example: ELA US24. See spec sheet ELA-StemKits.
ELA LRIS 277 X2	LED rough-in section (supplied standard with recessed exit unless PNL suffix is specified; order ELA LRIS 277 X2 only if needed for early installation).
ELA LRIS 120 X2	LED rough-in section (supplied standard with recessed exit unless PNL suffix is specified; order ELA LRIS 120 X2 only if needed for early installation).

Notes
1. Not available with EM option, consult factory for assistance.
2. See chart on back for more information.
3. Only available with single face.
4. Only available with double face.
5. Only available with CSA option.
6. Not available with top mount exits (TM).
7. No Rough-In section required. Attaches directly to J-box. Only available with AC operation.
8. When ordering recessed rough-in separately, all options must be included with rough-in nomenclature. Example: ELA LRIS 277 X2 F.
9. Choice of F or FI, not available with both. Not available with top mount exits.
10. Not available with CSA option.
11. Only available with non-emergency.
12. Rough-in supplied standard with exit unless PNL suffix is specified. Order separately only if needed for early installation.

X1

LRP Precise® LED Exit Signs

SPECIFICATIONS

ELECTRICAL EMERGENCY

Primary Circuit

Type	Typical LED life[1]	Supply voltage	Number of faces	Input watts	Max. amps
Red	10 years	120	1	2.3	.093
		277	1	2.7	.095
Red	10 years	120	2	3.2	.084
		277	2	3.9	.094
Green	10 years	120	1	1.7	.07
		277	1	1.9	.07
Green	10 years	120	2	3.7	.14
		277	2	3.8	.14

ELECTRICAL AC ONLY

Primary Circuit

Type	Typical LED life[1]	Supply voltage	Number of faces	Input watts	Max. amps
Red	10 years	120	1	1.5	.087
		277	1	1.8	.089
		347	1	2.2	.107
Red	10 years	120	2	3.1	.178
		277	2	3.4	.180
		347	2	4.1	.220
Green	10 years	120	1	1.2	.064
		277	1	1.3	.062
Green	10 years	120	2	2.0	.06
		277	2	2.3	.06

BATTERY

Sealed Nickel-Cadmium

Shelf life [2]	Typical life [2]	Maintenance[3]	Optimum temperature[4]
3 yrs.	7–9 yrs.	none	32°–100°F (0°-38°C)

Notes

1 Based on continuous operation. The typical life of the exit LED lamp is 10 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.

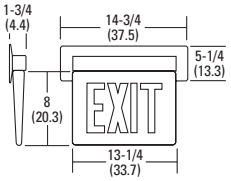
4 Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity.

MOUNTING

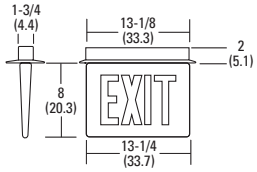
All dimensions are in inches (centimeters).

Shipping weight for panel: 5 lbs. (2.3 kgs.)

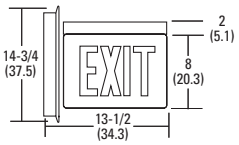
Shipping weight for rough-in section: 5.8 lbs. (2.6 kgs.)



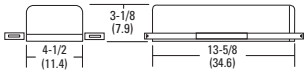
Back Mount (recessed)



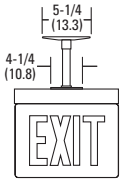
Ceiling Mount (recessed)



End Mount (recessed)



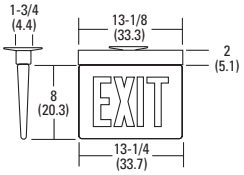
Rough -In Section



With Pendant Mounting kit (TM mounting only)

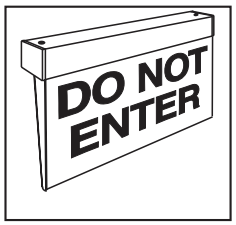
Directional Indicators

Specification (add to catalog number)	Graphics Back	Graphics Front
LA		
RA		
LRA (single face)		
DA		
LRA (double face)		

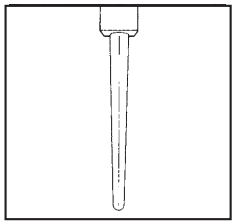


Top Mount (AC only operation)

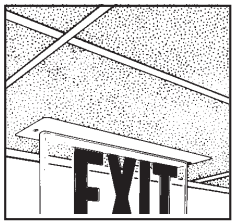
KEY FEATURES



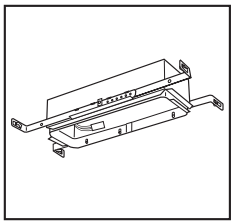
Silk-screening process allows customized text and/or graphics.



Unique wedge-shaped panel design concentrates light for uniform letter illumination.



Trim fits flush against wall or ceiling for clean, attractive appearance.



Small rough-in section.

LITHONIA LIGHTING®

LRP

EMERGENCY: One Lithonia Way Conyers, GA 30012 Phone: 800.334.8694 www.lithonia.com

SECTION 283100 - FIRE ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements.”

1.2 SUMMARY

A. This Section includes design and installation of a new fire alarm system.

B. Related Sections include the following:

1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Noncoded, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.

B. Fire alarm system shall consist of the following:

1. All new fire alarm control panel, devices, and wiring.
2. System smoke detection above all control panels and notification appliance power supply panels.
3. System smoke detection as required at air handling units, smoke rated transfer openings, and smoke damper locations.
4. System smoke detection in areas identified on plans
5. System carbon monoxide detection in areas identified on plans
6. All flow and tamper switches to monitor fire sprinkler and standpipe systems and report appropriate alarm and supervisory signals.
7. Manual fire alarm boxes at each building exit (prior to entering exit stairwells at each floor).
8. Audible and visual notification appliances in all public and common areas of the building.
9. Standby Generator monitoring.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Comply with NFPA 70.

C. Comply with NFPA 720.

D. A complete functional system meeting the requirements of this specification, including alarm initiating devices and notification appliances at locations and ratings to meet the requirements of the Authorities Having Jurisdiction and all applicable codes shall be provided.

E. Coordinate and avoid conflicts with casework, markerboards, feature walls, and other areas where fire alarm devices would interfere with furnishings, finishes, etc.

F. Fire alarm system vendor shall provide sound pressure level calculations demonstrating compliance with NFPA 72 and establish quantities and tap settings of audible devices.

G. No additional charges for work or equipment required for a code compliant system approved by the Authority Having Jurisdiction will be allowed.

H. Obtain and refer to mechanical drawings for smoke damper locations, smoke rated transfer openings, and air handling equipment CFM's. Provide smoke detection as required by applicable codes.

I. Premises protection includes Non-Separated Mixed Use Type building use group including Business Group B, Residential Group R-2, and Low-Hazard Storage Group S-2.

1. Refer to drawings for complete code analysis including construction type, use groups, special occupancy types, rated walls, smoke barriers and partitions, etc.

J. System functional performance shall be as indicated on the fire alarm matrix on the drawings.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:

   a. Trained and certified by manufacturer in fire alarm system design.
   b. Fire alarm certified by NICET, minimum Level III.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
3. Device Address List: Include address descriptions that will appear on the FACP display.
4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
6. Batteries: Provide battery sizing calculations. Battery size shall be a minimum of 125% of the calculated requirement.
7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

8. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show device layout, size and route of cable and conduits.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

G. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and Authorities Having Jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.

    a. Hard copies on paper to Owner, Architect, and Authorities Having Jurisdiction.
    b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

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.

1.8 EXTRA MATERIALS

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. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
2. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
3. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
4. Keys and Tools: One extra set for access to locked and tamperproofed components.
5. Audible and Visual Notification Appliances: One of each type installed.

6. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FACP and Equipment:

a. Edwards Systems Technology Inc.
b. NOTIFIER; a Honeywell Company.
c. Siemens Building Technologies, Inc.; a Cerberus Division.
d. SimplexGrinnell LP; a Tyco International Company.
e. Gamewell-FCI; a Honeywell Company.
f. National Time & Signal.
g. Xtralis.

2.2 FACP

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864, 9th edition, listed.
2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.
4. Mounting: Flush.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Signaling Line Circuits between control panels: NFPA 72, Class A, Style 7.
2. Signaling Line Circuits from control panel to devices: NFPA 72, Class B, Style 4.

a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.

3. Notification-Appliance Circuits: NFPA 72, Class B, Style Y.
4. Actuation of alarm notification appliances, and annunciation shall occur within 10 seconds after the activation of an initiating device.
5. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel FACP indication and system reset if the alarm is not verified.

E. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

F. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

G. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP after initiating devices are restored to normal.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

H. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones, or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall be UL 1711 listed.

a. Allow the application of and evacuation signal to indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
b. Programmable tone and message sequence selection.
c. Standard digitally recorded messages for "Evacuation" and "All Clear."
d. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACP.

2. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

K. Service Modem: The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

L. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.

1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."

M. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.

1. Battery and Charger Capacity: Comply with NFPA 72.

N. Surge Protection:

1. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key- or wrench-operated switch.

2.4 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

a. Sensor: LED or infrared light source with matching silicon-cell receiver.
b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where required.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay Fan Shutdown: Provide two (2) sets of contacts rated to interrupt fan motor-control circuit.
11. to communicate detector status (normal, alarm, or trouble) to the FACP.

2.5 SYSTEM CARBON MONOXIDE DETECTORS

A. General Description:

1. UL 2075 listed, operating at 24-V dc, nominal.
2. Provide means for addressable connection to fire-alarm system.
3. Detector must communicate detector status (normal, alarm, or trouble) to the FACP.
4. Detector must send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Detector must provide alarm contacts and trouble contacts.
6. Mounting: Adapter plate for outlet box mounting.
7. Testable by introducing test carbon monoxide into sensing cell.
8. Locate, mount, and wire in accordance with manufacturer's written instructions.
9. Test button simulates alarm condition.
10. written instructions.
11. Test button simulates alarm condition.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
2. Finishes:

    a. Wall mounted appliances: Provide red finish with white lettering.
    b. Ceiling Mounted Appliances: Provide white finish.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

1. Rated Light Output: 15, 30, 60, 75, 110, 135, 185 candela as required to meet NFPA 72 requirements.
2. Strobe Leads: Factory connected to screw terminals.

2.7 REMOTE STATUS AND ALARM INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

2.9 ADDRESSABLE CONTROL MODULE

A. Provide for integration of auxiliary control functions into the analog signaling circuit. Intelligent analog signaling circuit control module shall have the following capabilities:

1. Communication interaction with the analog signaling circuit having the capability of initiating a control function to an auxiliary device based on a specified event.
2. Provide NO/NC contact pairs rated at 2 amps 120 VAC or 24 VDC.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled according to UL 632.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.11 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Fire alarm wire and cable shall be as specified by the system manufacturer including conductor gage, conductor quantity, conductor twists and shielding required to meet NFPA class and style performance specified.

C. Signaling Line Circuits and other power limited fire alarm circuits (PLFA):

1. PLFA circuits installed in conduit or raceway: U.L. Listed type FPL
2. PLFA circuit cable installed exposed in accessible ceiling spaces, risers and elsewhere: U.L. Listed type FPLP.
3. PLFA circuits installed where 2 hr rating is required to meet the survivability requirements of NFPA 72: Circuit integrity cable, NFPA 70 Article 760, Classification CI, UL listed as Type FPL, FPLR or FPLP as required, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

D. Non-Power-Limited Fire Alarm Circuits (NPLFA):

1. NPLFA circuits installed in conduit: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

a. Low-Voltage Circuits: No. 16 AWG, minimum.
b. Line-Voltage Circuits: No. 12 AWG, minimum.

2. NPLFA circuit cable installed exposed in ceiling spaces, risers and elsewhere: Multi-conductor cable, U.L Listed type NPLFP.
3. NPLFA circuits installed where 2 hr rating is required to meet the survivability requirements of NFPA 72: Multi-conductor cable, U.L Listed type NPLFP-CI

2.12 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet or the listed spacing of the detectors, whichever is less.
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct.

D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

E. Remote Status and Alarm Indicators: Install near each smoke detector, each duct detector and each sprinkler water-flow switch and valve-tamper switch that is above 10’-0” aff, concealed, or otherwise not readily visible from normal viewing position. Coordinate exact locations with local fire department and submit to architect for approval.

F. Audible Alarm Notification Appliances: Install wall mounted appliances not less than 6 inches below the ceiling.

G. Visible Alarm Notification Appliances: Install wall mounted appliances at 96” AFF or 6 inches below the ceiling, whichever is less.

H. Coordinate ceiling mounted appliances with reflected ceiling plans. Do not install visual appliances where pendant mounted or suspended lighting fixtures will obstruct intended viewing angles.

I. Install wall mounted and ceiling mounted notification appliances flush on recessed j-box or back box for all new work and on existing gyp-board partition walls.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

K. FACP: Surface mounted with tops of cabinets not more than 72 inches above the finished floor.

1. Install smoke detector above panel. Install on ceiling for ceilings under 10 ft. For ceilings above 10', wall mount a smoke detector listed for releasing service 10' AFF or 1' below finished ceiling

L. Provide all 120V branch circuits for all control panels, sub panels, and ancillary equipment required for the system.

2.13 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method:

1. Fire alarm circuits shall consist of multi-conductor cables installed in accessible ceiling spaces.
2. Where ceilings consist of exposed construction, fire alarm multi-conductor cable shall be installed on top of joists, beams etc. and shall be concealed from view. Where the structural elements do not allow for the cable to be installed in a concealed fashion, then install the cable in conduit.
3. Install fire alarm cable in conduit in mechanical rooms, loading docks and similar service spaces.
4. Drops to surface mounted devices shall be installed in conduit or surface raceway. No exposed cable shall be visible below the ceiling. Where the ceiling is exposed, route the conduit or raceway up to the structural member that will conceal the cable.
5. Drops to devices recessed in partition walls shall be installed in conduit.
6. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
7. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits, if the system manufacturer permits it.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

2.14 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

2.15 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

2.16 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. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
2. Testing: Follow procedure and record results complying with requirements in NFPA 72.
3. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

2.17 PROGRAMMING

A. Coordinate final address descriptions for alarm, supervisory and trouble indication that appear on FACP and Annunciator displays with the Owners representative. This shall include all room names, room numbers, building areas for fire protection zones, exit door descriptions and similar items. This coordination shall take place and be implemented in the programming prior to Demonstration and Owner Training.

2.18 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

2.19 WARRANTY

A. All newly installed equipment shall be warranted by the contractor for a period of one year following acceptance. The warranty shall include parts, labor, prompt field service, pickup and delivery.

2.20 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Sections.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 283100

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping, or sealing site utilities.
7. Temporary erosion and sedimentation control.

1.2 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project Site.

1.3 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 FIELD CONDITIONS

A. 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 Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

E. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 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 erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
2. Use only hand methods or air spade for grubbing within protection zones.

B. 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 (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. 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. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses and plants.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks, driveway approaches and pavements.
6. Subbase course and base course for asphalt paving.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.2 DEFINITIONS

A. Backfill: Soil 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: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer 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: Aggregate layer 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 Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. 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.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct pre-excavation conference at Project Site.

1.4 INFORMATIONAL SUBMITTALS

A. Material test reports.

1.5 FIELD CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

B. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Topsoil: Provide reusable excavated (approved by landscape architect) or imported as required.

B. If reusable, stockpiled topsoil is insufficient, provide additional as required to complete the work. All material shall be friable loam, free of subsoil, roots, grass, excessive amounts of weeds, stone, and foreign matter.

C. Document quantities with weight tickets from independent weigh house.

D. Furnish written statement giving location and recent use of topsoil proposed for approval before delivery.

E. Subsoil: Reusable excavated or imported material shall be graded free of lumps larger than 6 inches and rocks larger than 3 inches, and miscellaneous debris.

2.2 FILL MATERIAL

A. 'Type A' (trench backfill) – granular materials used for pavement subbase shall meet Michigan Department of Transportation "2012 Standard Specifications for Construction" for "Class II" material, graded in accordance with Table 902-3. When Class II material is specified, Class I material may be substituted.

B. 'Type B' (aggregate base) – gravel shoulder and base course for drives and parking areas shall meet Michigan Department of Transportation "2012 Standard Specifications for Construction", 21AA limestone aggregate, graded in accordance with Table 902-2.

C. 'Type C' (stone for pipe bedding) – Stone shall meet the requirements of Series 6A aggregate, per the Michigan Department of Transportation Standard Specifications for Construction – 2012.

D. 'Type D' (embankment) – sand, natural river or bank sand, free of silt, clay, loam, friable or soluble materials, and organic matter.

E. 'Type E' (embankment) – select subsoil, consisting of not more than 15% clay or 20% silt and clay combined, free from scrap or other deleterious material, clean and unfrozen.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Notify Architect/Engineer immediately of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

C. Identify and flag known utility locations. Hand dig to verify horizontal and vertical locations of all underground utilities with project area.

D. Maintain and protect existing utilities remaining which pass through Work area.

E. Verify foundation walls are braced to support surcharge forces imposed by backfilling operations.

3.02 PROTECTION OF ADJACENT WORK

A. Underpin adjacent structures which may be damaged by excavation work, including service utilities and pipe chases.

B. Grade project area to prevent surface water run-off into excavation or to adjacent properties. Install soil erosion control measure prior to starting any site excavation or grading.

3.03 EXCESS WATER CONTROL

A. Do not place, spread, or roll and fill material during unfavorable weather conditions. Do not resume operations until moisture content and fill density are satisfactory to the soils Engineer.

B. Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collecting in depressions.

C. Where soil has been softened or eroded by flooding or replacement during unfavorable weather, remove all damaged areas and recompact as specified.

D. Provide and maintain at all times during construction, ample means and devices with which to remove promptly and dispose of all water from every source entering the excavations or other parts of the work.

E. Dewater by means which will ensure dry excavations and the preservation of the final lines and grades of bottoms of excavations.

3.04 TOPSOIL EXCAVATION

A. Do not excavate wet topsoil or topsoil with moisture content that exceeds plastic limit of material.

B. Excavate topsoil and stockpile in area designated by Architect/Engineer, and Owner on site, (after landscape architect approves quality of material) remove excess topsoil not being reused from site.

C. Do not excavate topsoil during unfavorable weather conditions such that the quality of construction may be impaired.

3.05 SUBSOIL EXCAVATION

A. Excavate subsoil to reach suitable bearing or as required for construction operations, and other Work. Excavate to depths shown and as required for retaining walls, pavement subbase, and other work as shown or specified.

B. Do not excavate subsoil during unfavorable weather conditions such that the quality of construction may be impaired.

C. Machine slope banks to angle of repose or less, until shored.

D. Excavation shall not interfere with normal 45 degree bearing splay of any existing or proposed foundation, road, or parking area.

E. Load bearing capacity of subsoil excavation at retaining wall footing level must exceed a minimum of 2000 lbs. per sq. ft.

F. If satisfactory subsoil conditions are not found at depth indicated on drawings, revise footings and excavations as directed by Architect/Engineer. Such additional work shall be paid for in accordance with unit prices as calculated for comparable work in proposal provided that such unit prices will not become an unfair burden on the Owner or Contractor.

G. If any piping, drains, construction materials, etc., are encountered in excavating, unless ordered removed, shall be supported, braced and protected from damage. If utility lines are encountered,

the Contractor shall notify the Architect/Engineer and not disturb lines unless so approved. Cooperate with the Owner and Architect/Engineer in their determination of additional work necessary.

H. Protect bottoms of excavations from frost. Provide, maintain and operate sufficient pumping equipment to keep all excavations free from water at all times. Discharge water a sufficient distance from foundations to prevent damage to work.

I. Legally dispose of excavated subsoil away from site.

J. The site shall be balanced onsite. The Contractor shall estimate the earthwork quantities and notify the Engineer/Architect if he believes the site will not balance. The costs to balance the site shall be included in the base bid.

3.06 TRENCHES

A. Excavate for storm sewer & miscellaneous piping on site to depths indicated and through whatever substances encountered.

B. Cut trenches sufficiently wide to enable installation of utilities and allow inspection. Excavated material shall be piled a sufficient distance from banks of excavation to avoid overloading and to prevent slides and cave-ins.

C. All excavation shall be made by open cut unless otherwise indicated.

D. The banks of trenches shall slope or be supported in accordance with all pertinent rules and regulations.

E. Trenches shall be no less than 12 inches nor more than 16 inches wider than the outside diameter of the pipe laid therein, and shall be excavated true to line, so that clear space of not less than 6 inches nor more than 8 inches in width is provided on each side of the pipe. The maximum width of the trench specified applies to the width of any point below the level of the top of the pipe. The width of the trench above that level may be as wide as necessary for sheathing and bracing, and the proper installation of the work, but care shall be taken not to injure abutting property.

F. Hand trim excavation and leave free of loose matter. Hand trim for bell and spigot pipe joints. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for sections where it is necessary to excavate for bell holes.

G. Excavate approximately 4” deeper than the required level, and bed the pipe or appurtenances in clean ‘Type A’ material unless otherwise shown on the construction plans. The bedding material shall be added to extend upward at least half the diameter of the pipe or 12”, whichever is higher. This bedding procedure will be used in all cases of over excavation at the expense of the Contractor.

H. Support pipe during placement and compaction of bedding fill. Backfill and compact each side of pipe equally and concurrently.

I. Excavation for catch basin structures, and other accessories shall be sufficient to leave at least 24 inches clearance between their outer surfaces and the embankment or timber which may be used to hold the banks and to protect them.

J. After the jointing is completed and the pipe has been approved, the trench shall be backfilled by hand to a one foot depth over the top of the pipe. The backfill materials shall be placed evenly around and over the pipe in six inch layers and thoroughly compacted by tamping. Remaining backfill to be placed to required contours and elevations.

K. Trench backfill within the limits of asphalt or concrete paving shall require special compaction to a density not less than 95% of the maximum density determined by the Test ASTM D1557 (Modified Proctor).

L. Backfill and compaction around structures and other appurtenances shall be in lifts not to exceed 8 inches and shall be compacted to a density not less than 95% of the maximum density determined by the Modified Proctor Test ASTM D698-70.

3.07 BACKFILLING

A. Backfill areas to contours and elevations, using unfrozen materials.

B. Backfill systematically, as early as possible, to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Place and compact fill materials in continuous layers not exceeding 8 or 12 inches loose depth as indicated in the schedule below.

D. Employ a placement method so as not to disturb or damage foundation perimeter drainage or utilities in trenches.

E. Maintain optimum moisture content of backfill materials to attain required compaction density.

F. Do not backfill against unsupported foundation walls.

G. Slope grade away from building, minimum of 1.0% unless otherwise noted.

3.08 PLACING TOPSOIL

A. Place topsoil in areas where seeding is scheduled or over entire area within contract limits to a rolled depth of 4”. Provide additional topsoil if required to complete the work.

B. Fine grade topsoil eliminating rough or low areas. Maintain levels, profiles, and contours of subgrade.

C. Remove stone, roots, grass, weeds, debris, and foreign material while spreading.

D. Lightly roll placed topsoil.

E. Leave site clean and raked, ready to receive landscaping.

3.09 TESTS

A. Tests and analysis of fill materials will be performed in accordance with ANSI/ASTM D1557.

B. Contractor and testing laboratory shall confirm with Architect/Engineer selected test points and frequency.

3.10 TOLERANCES

A. Top surface of exposed subgrade: plus or minus 0.10'.

B. Top of topsoil: plus or minus 0.10'.

3.11 SCHEDULES

A. Exterior side of retaining wall. Material for this backfill shall be 'Type A' for a distance of five feet from the foundation walls. Each 8" lift shall be compacted to 95%. Backfill beyond the five feet limit shall be 'Type E', compacted in 12" lifts to 90%.

B. Fill under landscaped areas, subsoil 'Type E' as required to meet design grades, compacted in 12" lifts to 85%. Hold down 4" to accommodate topsoil installation.

C. Subbase fills under parking lots and streets where required: 'Type B', depth as indicated on drawings, compacted in 8" lifts to 95%.

3.12 COMPACTION

A. Compacting equipment shall be heavy duty, 20 ton minimum capacity, rolling drum, vibrating compactors or other compacting equipment may be used with the approval of the Soils Engineer retained to observe proof compaction.

B. Compacting equipment shall not require more than six passes to obtain specified density.

C. The above methods or other suitable methods capable of producing equivalent results with the available material may be used with the approval of the Testing Laboratory and the Soils Engineer.

D. Compacting around concrete pedestals and next to foundation walls shall be with hand operated vibrating compactors for granular soils and Barco rammer type compactors for clay soils.

E. Granular soils of relatively uniform grain size and very small amounts of fine binder material may have their density established by the Relative Density (ASTM D2049) method. Compaction of all cohesionless soil fill shall be at least 75% Relative Density.

F. If fill material is too dry, the Contractor shall provide and operate approved means to add moisture to layers.

G. The moisture content shall be checked by the Testing Laboratory and operations concerning placing fill shall be under their control.

END OF SECTION 312000

SECTION 312500 – SOIL EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Temporary and permanent measures for soil erosion and sedimentation prevention and control.

1.02 SYSTEM DESCRIPTION

A. Methods of control are identified on the Soil Erosion and Sedimentation Control drawings.

B. Additional control measures shall be employed as required by site conditions and applicable governing agencies having project jurisdiction.

1.03 QUALITY CONTROL

A. Perform and maintain Work in accordance with the Soil Erosion and Sedimentation Control Act 347 of 1972, any amendments to, and corresponding rules of the Michigan Water Resources Commission.

1.04 REGULATORY REQUIREMENTS

A. Contractor shall obtain all permits and pay all fees for plan review and inspection as required by applicable governing agencies having project jurisdiction.

B. Detailed soil erosion control plan is required for all projects that are within 500 feet of any water course, or are one (1) acre or more in area.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Permanent Measures: In accordance with applicable Section for specified material.

B. Temporary Measures: In accordance with Standards and Specifications for Soil Erosion and Sediment Control published by the Association of Soil Conservation Districts.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Identify and flag known utility locations. Notify utility company to remove or relocate utilities as required.

C. Maintain and protect existing utilities to remain.

3.02 PROTECTION OF ADJACENT WORK

A. Protect adjacent structures and property which may be damaged by execution of Work.

B. Protect existing trees, shrubs, landscaping and lawn areas designated to remain.

3.03 INSTALLATION AND MAINTENANCE

A. Construct soil erosion and sedimentation control measures in accordance with approved plans and requirements of applicable governing public agency.

B. Schedule planned control measures with construction operations to limit the area of any disturbed land to the shortest possible period of exposure.

C. Conduct all earth changes so as to effectively reduce accelerated soil erosion and resulting sedimentation.

D. Remove all sediment from runoff water before it leaves the site.

E. Roads, driveways, and parking lots must be kept clean at all times during construction.

F. Inspect, maintain, and repair temporary control measures until permanent control measures are implemented.

G. Maintain permanent control measures until final acceptance by Owner.

3.04 SOIL EROSION AND SEDIMENTATION CONTROL MEASURES

A. Permanent and minimum temporary control measures as scheduled on Drawings.

END OF SECTION 312500

SECTION 313000 – UTILITY TRENCHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Excavating trenches for underground piping and utilities.

B. Compacted fill from top of utility bedding to subgrade elevations.

C. Backfilling and compaction.

1.2 REFERENCES

A. ANSI/ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.

B. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures using 10 lb Hammer and 18 inch Drop.

C. ASTM D2922 - Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow depth).

D. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil Aggregate Mixtures.

1.3 DEFINITIONS

A. Utility: Any underground pipe, conduit or cable.

1.4 FIELD MEASUREMENTS

A. Verify that survey benchmark and intended elevations for the Work are as shown on drawings.

1.5 COORDINATION

A. Coordinate work under provisions established in these contract documents.

B. Verify work associated with lower elevation utilities are complete before placing higher elevation utilities.

PART 2 - MATERIALS

2.1 FILL MATERIALS

A. Earth Backfill trench detail as specified in current MDOT Standard Plans for Construction – Utility Trenches, Standard Plan R-83A.

B. Class II Granular Material as specified in Section 902 of the MDOT 2012 Standard Specifications for Construction

C. Concrete: Lean concrete with a compressive strength of 2000 psi.

PART 3 - EXECUTION

3.1 PREPARATION

A. Identify required lines, levels, contours and datum.

B. Protect plant life, lawns, and other features remaining as a portion of final landscaping.

C. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

D. Maintain and protect above and below grade utilities which are to remain.

E. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with material specified and compact to density equal to or greater than requirements for subsequent backfill material.

3.2 EXCAVATION

A. Excavate subsoil required for utilities.

B. Excavation shall be of sufficient widths and depths to provide adequate room for construction, bedding and installation of the work to lines, grades and dimensions called for on plans. Trench width from invert to a height 12 inches above top of utility shall conform to schedule at the end of this Section.

C. Do not interfere with 45 degrees bearing splay of foundations.

D. Hand trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

E. Correct areas over-excavated with Class II granular material or as approved by engineer.

F. Remove excess excavated material from site.

3.3 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

C. Class II Granular Materials are to be placed and compacted in continuous layers not exceeding 8 inches compacted depth.

D. Earth Backfill under grass areas shall be placed and compacted with suitable material in continuous layers not exceeding 12 inches compacted depth.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Leave fill material stockpile areas completely free of excess fill materials.

3.4 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

B. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.5 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions set forth in other sections of these construction documents.

B. Compaction testing will be performed in accordance with ANSI/ASTM D1557.

C. If tests indicate Work does not meet specified requirements, remove Work, replace, compact and retest.

D. Frequency of Tests: Every 25 ft., as requested by Engineer, and under pavements.

3.6 PROTECTION OF FINISHED WORK

A. Protect installed Work as acceptable to Engineer.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.7 SCHEDULES

A. Trench widths for hollow conduits:

Pipe Diameter	Maximum Trench Width
4" to 12"	30"
15" to 36"	Pipe O.D. + 12"
42" & greater	Pipe O.D. + 24"

B. Backfill requirements
1. Concrete and Asphalt Pavements, Sidewalks, Driveways and Parking Areas:
   a. Crossing Paved Area - Backfill shall be mechanically tamped sand or gravel (suitable excavated sand or gravel material may be used), placed in 12 inch lifts, loose measure. Compaction shall be a minimum 95% of maximum unit weight.
   b. Parallel trenches within a 1:1 influence from the top surface of a paved area shall meet same requirements as a crossing trench.
   c. Parallel trench outside a 1:1 influence from the top surface of a paved area - Backfill material shall be placed into trench in 12 inch lifts, loose measure, with each lift compacted to not less than 90% of maximum weight. Excavated material may be used provided compaction requirements can be met.

2. Gravel Roads, Driveways and Parking Areas

Crossing Gravel Pavement: Backfill material shall be placed into trench in 6 inch lifts, loose measure, with each lift compact to not less than 90% maximum unit weight. Excavated material may be used provided compaction requirement can be met. The Contractor shall immediately restore the roads, driveways and parking areas with MDOT 21A gravel or slag aggregate, at least 8 inches thick and shall maintain them in good, dust-free condition during the life of the contract. Additional aggregate shall be added if settlement occurs. Before final acceptance of the road, driveway or parking area, it shall be topdressed with approved material to match the original surface treatment. Gravel shall be suitably stabilized with calcium chloride. Oil shall be placed on gravel, if necessary, to match original surface treatment.

3. Open Fields and Lawn Areas

Trenches in lawn areas shall be backfilled with excavated material placed into the trench in 12 inch lifts, with each lift thoroughly compacted to 90% of its maximum unit weight.

All other trenches shall be backfilled by spreading backfill material neatly into trench. Contractor shall regrade as necessary during the life of the contract.

4. Special Backfill

Where called for on the plans or where required by “Road Permits”, the Contractor shall backfill trenches and/or other excavation in 6 inch deep lifts, loose measure, with each lift compacted in accordance with the requirements of said plans or “Road Permits” before the succeeding lift is placed.

At all locations where “Special Backfill Requirements” are called for on the plans, the Owner will employ an independent testing laboratory to perform compaction tests. The Contractor and the testing laboratory shall work together to establish guidelines which, under reasonable circumstances, shall produce the desired compaction results. The costs of all successful results will be paid for by the Owner. Costs for retesting areas which fail will be paid for by the Contractor. Compaction to 95% modified proctor.

END OF SECTION 313000

SECTION 321123 - AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Aggregate base course.

1.2 REFERENCES

A. MDOT 2012 Standard Specifications for Construction
B. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures using 10 lb Hammer and 18 inch Drop.
C. ASTM D2922 - Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow depth).
D. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil Aggregate Mixtures.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Aggregate Base Course shall meet the requirements of Section 302 of the 2012 MDOT Standard Specifications for Construction and shall consist of material called for on the plans.
B. MDOT 21AA, Dense Graded Crushed Aggregate.
C. MDOT Class II Granular Material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify substrate has been inspected, gradients and elevations are correct and dry.

3.2 AGGREGATE PLACEMENT

A. Spread aggregate over prepared subbase to a total compacted thickness as shown on plans.
B. Place aggregate in maximum 8 inch layers and roller compact.
C. Level and contour surfaces to elevations and gradients indicated.
D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.3 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation from True Elevation: Within ½ inch.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01400.

B. Compaction testing will be performed in accordance with ANSI/ASTM D1557, ASTM D2922, ASTM D3017.

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: 50 Ft.

3.5 SCHEDULES

A. Under Asphalt Pavement:

1. Compact MDOT 21AA aggregate materials to achieve compaction to 95 percent.

B. Under Concrete Sidewalks and Slabs

2. Compact Class II granular materials to achieve compaction of 95 percent.

END OF SECTION 321123

SECTION 321216 – ASPHALT PAVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

B. Bituminous concrete paving

1.02 RELATED REQUIREMENTS

A. Section 312000 Earth Moving.

1.03 RELATED REQUIREMENTS

A. AI MS-2 -Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types; The Asphalt Institute; 1994.

B. AI MS-19 -A Basic Asphalt Emulsion Manual; The Asphalt Institute; Third Edition.

C. ASTM D 946 -Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction; 1982 (Reapproved 2005).

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with MDOT 2012 Standard Specifications.

B. Mixing Plant: Conform to MDOT 2012 Standard Specifications.

C. Obtain materials from same source throughout.

1.05 FIELD CONDITIONS

A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F.

B. Place bituminous mixture when temperature is not more than 15 F degrees below bituminous supplier's bill of lading and not more than maximum specified temperature.

PART 2 -PRODUCTS

2.01 MATERIALS

A. Asphalt Wearing Course; In accordance with MDOT 2012 Standard Specifications for MDOT 13A (Tier 1, 17% max. RAP) Mix.

B. Asphalt Leveling Course; In accordance with MDOT 2012 Standard Specifications for MDOT 3C Mix.

C. Aggregate for Base Course; MDOT 2012 Standard Specifications for MDOT 21AA Crushed Limestone Aggregate.

D. Fine Aggregate Sand; In accordance with MDOT Class II sand.

E. Primer: In accordance with MDOT 2012 Standard Specifications.

F. Tack Coat: In accordance with MDOT 2012 Standard Specifications.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

A. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.03 SOURCE QUALITY CONTROL

A. Test mix design and samples in accordance with MDOT 2012 Standard Specifications.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Verify that compacted subgrade; granular base and stabilized soil are dry and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.02 BASE COURSE

A. Place and compact base course to 98% of its maximum unit weight.

3.03 PREPARATION - PRIMER ASPHALT PAVING

A. Apply primer in accordance with manufacturer's instructions.

B. Apply primer to contact surfaces of curbs.

3.04 PREPARATION -TACK COAT

A. Apply tack coat in accordance with manufacturer's and MDOT Standard Specifications.

B. Apply tack coat to contact surfaces of curbs.

3.05 PLACING ASPHALT PAVEMENT

A. Install Work in accordance with 2012 MDOT Specification for Construction.

B. Place asphalt within 24 hours of applying primer or tack coat.

C. Place asphalt to required compacted thickness.

D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.06 PLACING ASPHALT OVERLAY

A. Apply tack coat to existing paving surface in accordance with manufacturer's and MDOT Standard Specifications.

B. Place asphalt within 24 hours of applying primer or tack coat.

C. Place asphalt to required compacted thickness.

D. Compact overlay by rolling.

E. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

F. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.07 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

B. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.

3.08 PROTECTION

A. Immediately after placement, protect pavement from mechanical injury for 3 days or until surface temperature is less than 140 degrees F.

END OF SECTION 321216

SECTION 321313 – CONCRETE PAVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks, drive approaches and flat work

1.02 RELATED REQUIREMENTS

A. Section 312000 – Earth Moving; Preparation of site for paving and base.

B. Section 321216 – Asphalt Paving.

1.03 REFERENCE STANDARDS

A. ACI 211.1 -Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).

B. ACI 301 -Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.

C. ACI 304R -Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.

D. ACI 305R -Hot Weather Concreting; American Concrete Institute International; 1999.

E. ACI 306R -Cold Weather Concreting; American Concrete Institute International; 1988 (Reapproved 2002).

F. ASTM A 185/A 185M -Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.

G. ASTM A 497/A 497M -Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete; 2007.

H. ASTM A 615/A 615M -Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2007.

I. ASTM C 33 -Standard Specification for Concrete Aggregates; 2007.

J. ASTM C 39/C 39M -Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2005.

K. ASTM C 94/C 94M -Standard Specification for Ready-Mixed Concrete; 2007.

L. ASTM C 150 -Standard Specification for Portland Cement; 2007.

M. ASTM C 173/C 173M -Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2007.

N. ASTM C 260 -Standard Specification for Air-Entraining Admixtures for Concrete; 2006.

O. ASTM C 309 -Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2007.

P. ASTM C 494/C 494M -Standard Specification for Chemical Admixtures for Concrete; 2008.

Q. ASTM C 618 -Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2005.

R. ASTM C 685/C 685M -Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2007.

S. ASTM D 1751 -Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (nonextruding and Resilient Bituminous Types); 2004.

T. ASTM D 1752 -Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a.H. The Contractor shall not add fill until the subgrade in place has been approved by the soils lab.

PART 2 - PRODUCTS

2.01 PAVING ASSEMBLIES CONCRETE

A. Comply with applicable requirements of ACI301. City of Warren Standards and MDOT Standards.

B. Concrete Sidewalks: 3,500 psi 28 day concrete, 4 inches thick.

C. Concrete Drive Approaches, Sidewalk across Drive Approaches and Flatwork: 3,500 psi 28 day concrete, 8 inches thick.

2.02 FORM MATERIALS

A. Form Materials: Conform to AC1301; As specified in City of Warren Standards and MDOT Standards.

B. Wood; Steel; or form material, profiled to suit conditions.

C. Joint Filler: Preformed; non-extruding bituminous type (ASTM D 1751); sponge rubber or cork (ASTM D 1752).

2.03 CONCRETE MATERIALS

A. Obtain cementitious materials from same source throughout.
B. Concrete Materials: Provide in accordance with MDOT 2012 Standard Specifications for Construction Standard P1 mix.

C. Cement: Portland Cement as described in Division 6 of the MDOT 2012 Standard Specifications.
D. Fine and Coarse Mix Aggregates: ASTM C 33.

E. Water: Clean, potable, and not detrimental to concrete.

F. Air Entrainment Admixture: ASTM C 260.

G. Chemical Admixtures: ASTM C 494/C.
1. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

2.04 ACCESSORIES

A. Curing Compound: ASTM C 309, Type 2.

B. Joint Sealer: Type as specified in the MDOT 2012 Standard Specifications, Section 914.

2.05 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience; trial mixtures; or , as specified in ACI 301.
1. For trial mixtures method, employ independent testing agency acceptable to Design Professional for preparing and reporting proposed mix designs.

C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

D. Concrete Properties:
1. As detailed in the MDOT 2012 Standard Specifications for P1 Mix.

2.06 MIXING

A. On Project Site: Mix in drum type batch mixer, complying with ASTM C 685. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

B. Transit Mixers: Comply with ASTM C 94/C 94M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade; granular base; stabilized soil; or is acceptable and ready to support paving and imposed loads.

3.02 SUBBASE

A. See Section 312000 for construction of base course for work of this Section.

B. Prepare subbase in accordance with MDOT and the Soils Engineers' recommendations.

3.03 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Verify gradients and elevations of base are correct.

C. Notify Design Professional minimum 24 hours prior to commencement of concreting operations.

3.04 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 COLD AND HOT WEATHER CONCRETING

A. Follow recommendations of ACI 305R when concreting during hot weather.

B. Follow recommendations of ACI 306R when concreting during cold weather.

C. Do not place concrete when base surface temperature is less than 40 degrees F; or surface is wet or frozen.

3.06 PLACING CONCRETE

A. Place concrete in accordance with AC1304R; as specified in Section 033000.

B. Place concrete in accordance with MDOT Standards.

C. Do not place concrete when base surface is wet.

D. Placing concrete using the slip form technique is acceptable.

E. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.

F. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

G. Place concrete to pattern; or pattern indicated.

3.07 JOINTS

A. Align sidewalk joints.

B. Provide scored or sawn joints between sidewalks.
C. Place joints in accordance with MDOT standards.

D. Saw cut contraction joints at an optimum time after finishing.

3.08 FINISHING

A. Paving: Light broom, texture perpendicular to pavement direction.

B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel.

C. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.09 JOINT SEALING

A. See Section 079005 for joint sealer requirements.

3.10 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch.

B. Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01400. Provide free access to concrete operations at project site and cooperate with appointed firm. Submit proposed mix design of each class of concrete; or None -N/A to inspection and; or None -N/A testing firm for review prior to commencement of concrete operations. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

B. Compressive Strength Tests: ASTM C 39/C 39M. For each test, mold and cure three; concrete test cylinders. Obtain test samples for every 75 cu yd; less of each class; of concrete placed. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents. Perform one slump test for each set of test cylinders taken.

C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian or vehicular traffic over pavement for 7 days minimum after finishing.

END OF SECTION 321313

SECTION 321600 – CONCRETE CURB AND GUTTER

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This work includes all preparation, forming, concrete production and placement, finishing, jointing, reinforcing, curing, protection, and restoration for the construction of concrete curb and gutter.

B. The concrete curb and gutter shall be constructed substantially in accordance with the cross section provided on the plans.

C. Curb and gutter may be constructed either by slip-forming or using fixed forms.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland cement shall meet the requirements of ASTM C150.

B. Coarse aggregate shall meet the requirements of Class 6A aggregate as described in the 2012 Michigan Department of Transportation Standard Specifications for Construction.

C. Reinforcing steel shall be grade 60 steel bars meeting the requirements ASTM A615, A616, or A617.

D. White membrane curing compound shall conform to ASTM C309, Type 2, Class B vehicle.

E. Fiber joint filler shall meet the requirements of ASTM D1751.

2.02 MIXTURES

A. Concrete for curb and gutter shall be transit mixed concrete in accordance with ASTM C94.

B. Air content shall be 6.5 +- 1.5%, slump shall not exceed 3 inches, and compressive strength shall be at least 3500 psi after 28 days. Air content for slip form placement shall be 4.5 +- 1.5%, slump shall not exceed 1.5 inches, and compressive strength shall be at least 3500 psi after 28 days. Concrete shall contain at least six sacks of cement per cubic yard of concrete.

PART 3 - EXECUTION

3.01 REMOVAL OF EXISTING CURB AND GUTTER

A. Where the proposed curb and gutter is to replace existing curb and gutter, the existing curb and gutter shall be removed in accordance with the requirements for pavement removal, included elsewhere in these documents.

3.02 PREPARATION

A. The base shall be excavated, filled, and shaped as required to construct the proposed curb and gutter at the elevations and alignment required. The base shall be compacted to at least 95% of its maximum unit weight as determined by ASTM D1557. Soft and yielding material shall be excavated and replaced with suitable soils.

B. Forms, if used, shall extend the full depth of the concrete. Face forms for the exposed curb face are not required. Forms shall be of sufficient strength and staked to prevent springing or yielding after placement of concrete. Flexible forms capable of making a smooth arc shall be used for curved sections.

C. Steel reinforcement shall be placed as shown on the plans. Reinforcing shall be spliced and held in place in a manner approved by the Engineer. Splices shall be overlapped by 10 inches.

3.03 PLACING CONCRETE

A. Concrete shall not be placed until the forms or the prepared grade (if slip forming) have been inspected by the Engineer. Concrete shall be deposited to the full depths and spaded or vibrated to ensure proper consolidation.

B. Joints shall be constructed perpendicular to the surfaces and shall not vary more than 1/4 inch from their designated position. Contraction joints shall be spaced at 50 foot intervals and shall be at least 1/4 the thickness of the section. Steel reinforcing shall not extend through contraction joints. Expansion joints shall be constructed at spring points, at intervals not exceeding 400 feet, and 10 to 50 feet each side of a drainage structure. Expansion joints shall be 1 inch thick and extend through the full cross section of the curb and gutter. Plane-of-weakness joints shall be provided at uniform spacing, not exceeding 10 feet. Plane-of-weakness joints shall extend through at least 1/4 the thickness of the section.

C. The edges of the gutter, the back of the top edge of curb, and all transverse joints shall be rounded with a finishing tool having a radius of 1/4 inch. The face of the curb, at the top and bottom, shall be shaped with suitable tools to provide the required radius.

D. Any material required to fill low spots shall be obtained from the mixture used in the work. Exposed surfaces shall be finished smooth and even by means of a moistened wood float, followed by light brushing.

E. The gutter and top of curb shall not vary more than 3/16 inch in 10 feet when using a 10 foot straight edge. Other surfaces shall not vary more than 3/8 inch in 10 feet.

F. Water shall not be added as an aid to finishing.

G. Exposed concrete surfaces shall be cured using white membrane curing compound applied uniformly at a rate of 200 square feet per gallon. Curing compound shall be applied regardless of temperature or humidity conditions.

3.04 PROTECTION

A. Concrete shall not be placed when the air away from artificial heat is at least 25F and rising. Concrete shall be protected from damage by freezing or precipitation.

B. The Contractor shall provide barricading and security as necessary to protect fresh concrete from accidental damage or vandalism. Damaged concrete shall be removed to a joint and replaced at the Contractors expense.

3.05 CLEAN-UP AND RESTORATION

A. Forms shall be removed when the concrete has attained sufficient strength. After removal of forms, the curb and gutter shall be backfilled.

B. Areas to be restored with turf shall be backfilled with suitable soil, compacted, and surfaced with four inches of topsoil such that the topsoil surface is flush with the top of curb. Areas to be surfaced with pavement or sidewalk shall be backfilled with sand to the bottom of the proposed pavement, sidewalk, or base, and compacted.

C. Where curb and gutter is constructed adjacent to an existing pavement, the void between the curb and gutter and the pavement shall be filled full depth with material in like kind as the existing pavement.

END OF SECTION 321600

SECTION 321723 – PAVEMENT MARKING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.02 SUMMARY

A. The work under this section includes, but is not necessarily limited to the furnishing and installation of all materials necessary for placing pavement markings as indicated on drawings and specifications.

1. Markings on concrete pavement areas.
2. Markings on asphalt pavement areas.

B. Related Sections include the following:

1. Division 321216 Section “Asphalt Paving.”
2. Division 321313 Section “Concrete Pavement.”

1.03 QUALITY ASSURANCE

A. MDOT Specifications: Unless otherwise indicated on drawings or herein specification, all work under this section shall be performed in accordance with the current 2012 MDOT Standard Specifications for Highway Construction.

B. Physically Handicapped: All marking shall be done in accordance with ADA Requirements.

C. Paint Containers: Each paint container shall be plainly marked, with a durable, weather-resistant marking, showing the name and address of manufacturer or vendor, description of material, batch number, date of packaging and volume and weight of contents.

D. Use only personnel completely trained and experienced in installation of materials and equipment.

1.04 SUBMITTALS

A. Manufacturer's literature: Submit descriptive product data of materials, installation methods and procedures.

B. Certification of compliance: Furnish a certification from manufacturer that material for this project has been sampled, tested and complies with requirements of specifications.

1.05 PRODUCT HANDLING

A. Protection: Use all means necessary to protect materials before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the architect at no additional cost to owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials and products for work under this section shall conform to current 2012 MDOT Standard Specifications for Highway Construction.

2.02 PAVEMENT MARKING PAINT

A. Pavement marking paint shall be fast dry and comply with Section 6.29 of 2012 MDOT Standard Specifications for Highway Construction and shall be selected from the following list of approved products.

COMPANY	IDENTIFICATION	YELLOW	WHITE
Baltimore Paint & Chemical Co.		BP29-56/TM9451	BP29-55/TM9450
DeSantis Coatings, Inc.		12Y-D194/K663	
Ennis Paint Mfg., Inc.		EN-6055	EN-4038
Ennis Paint Mfg., Inc.		EN-6054	
Prismo Universal Corporation		LW86-24D	LW84-95A

B. Provide required colors for all physically handicapped markings, complying with governing agencies having jurisdiction.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection: Prior to all work of this section, carefully inspect installed work of all trades and verify all such work is complete to the point where installation may properly commence. Verify all pavement markings may be installed in accordance with all pertinent codes and regulations, authorities having jurisdiction and referenced standards.

B. Discrepancies: In the event of discrepancy, immediately notify the architect. Do not proceed with installation in areas of discrepancies until all have been fully resolved.

3.02 SURFACE PREPARATION

A. Cleaning: Prior to application of pavement marking, it shall be marking contractor's responsibility that pavement surfaces are clear, dry and free of all foreign materials.

B. New pavement curing: new bituminous wearing surface shall be in place for period of not less than fourteen days prior to application of Fast Dry pavement markings.

3.03 CONSTRUCTION METHODS

A. Application: Pavement markings shall be solid 4" wide yellow lines or solid 4” wide blue lines for ADA accessible parking and laid out as indicated on drawings. Paint shall be applied uniformly at a minimum rate of sixteen gallons per mile for single 4" solid line. Markings shall be applied so that they adhere adequately to surface.

B. Protection of wet paint shall be responsibility of contractor. Markings obliterated by traffic shall be retraced at contractor's expense.

3.04 DEFECTIVE WORK

A. Improper location: Improperly located markings shall be removed at contractor's expense in a manner acceptable to architect and reapplied in correct locations at contractor’s expense.

B. Material shortage: Markings which are applied with material shortages shall be properly reapplied at contractor's expense.

3.05 CLEAN UP

A. Upon completion of the work of this section, remove all rubbish, trash and debris resulting from work of this section. Leave site in neat and orderly condition.

END OF SECTION 321723

SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for each type of exposed finish requiring color selection.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

1. Cast-in-Place Detectable Warning Tiles shall be manufactured or supplied by ADA Solutions, Inc. or Armor-Tile.
2. Material: Molded glass- and carbon-fiber-reinforced polyester or Vitrified Polymer Composite (VPC).
3. Color: Federal color #22144.
4. Shapes and Sizes:

a. Rectangular panel, 24 inches x 60 inches.

5. Dome Spacing and Configuration: 1.67-inch (42.4-mm) spacing.
6. Mounting:

a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.

PART 3 - EXECUTION

3.1 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

C. Cast-in-Place Detectable Warning Tiles: Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedment's in wet concrete by tamping or vibrating. Set surface of tile flush with surrounding concrete and adjacent tiles. Remove concrete from tile surfaces and clean using methods recommended in writing by manufacturer.

D. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

E. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

SECTION 322810 – IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Attention is directed to Bidding and Contract Requirements, and General and Supplemental Requirements, which are hereby made a part of this Section. Refer to Sheet LP-2: Landscape Details/Notes; Note #18.

1.02 DESCRIPTION OF WORK:

A. Contractor to install an Automated Irrigation System for all lawn and plating bed areas within the project site(s) in accordance with the drawings, notes and these specifications. Contractor to investigate the existing irrigation system to expand and/or modify the system into all new construction areas.

B. Limits of areas to be irrigated are shown on drawings and by provisions of this Section.

C. The sprinkler system shall be constructed using sprinklers, valves, piping, fittings, controllers, wiring, etc., of size and types as shown on drawings and as called for in these specifications. The system shall be constructed to grades and conform to areas and locations as shown on the drawings.

D. A diagrammatic sprinkler system is not shown on these drawings and is to be designed by the Landscape Contractor as part of the bid package. Landscape Architect is to approve submitted irrigation proposal, layout & design, PVC sleeve locations, materials, line, valve and head locations.

E. Unless otherwise specified or indicated on the drawings, the construction of the sprinkler system shall include the furnishing, installing and testing of all mains, laterals, risers and fittings, sprinkler heads, quick coupling valves, control valves, and other necessary specialties and the removal and/or restoration of existing improvements, excavating and backfill, and all other work in accordance with plans and specifications as required for a complete system.

F. Related work specified elsewhere:

1. Section 329200: Sodding
2. Section 329300: Trees, Plants and Ground Covers

1.03 QUALITY ASSURANCE:

A. The Contractor shall maintain continuously a competent superintendent, satisfactory to the Owner, with authority to act for him in all matters pertaining to the work.

B. The Contractor shall coordinate his work with the other trades.

C. The Contractor shall confine his operations to the area to be improved and to the areas allotted him by the Owner's representative for material and equipment storage.

D. The Contractor shall have a minimum of 5 years experience installing irrigation systems of comparable size and complexity.

1.04 SUBMITTALS:

A. Irrigation system design indicating location of PVC sleeves, water lines, valves, valve boxes, controller, heads, zones and additionally required information.

B. Submit product information on controller, wire connectors, pipe and fittings to be used on the project prior to purchasing materials.

C. Upon irrigation system acceptance, submit written operating and maintenance instructions. Provide format and contents as directed by the Landscape Architect. Include instruction sheets and parts lists for all operating equipment.

D. Provide a reproducible irrigation system record drawing showing mainline and valve locations.

1. Legibly mark drawings to record actual construction.

2. Indicate horizontal locations, with a minimum of two dimensions to permanent surface improvements.

3. Identify field changes of dimension and detail and changes made by Change Order.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Deliver irrigation system components in manufacturer's original undamaged and unopened containers with labels intact and legible.

B. Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends, both threaded and plain.

C. Store and handle materials to prevent damage and deterioration.

D. Provide secure, locked storage for valves, sprinkler heads and similar components that cannot be immediately replaced, to prevent installation delays.

1.06 PROJECT CONDITIONS:

A. The bidder acknowledges that he has examined the site, plans and specifications, and the submission of a proposal shall be considered evidence that examination has been made.

B. It shall be the contracting installer's responsibility to report to the Owner's authorized representative any deviations between drawings, specifications and the site. Failure to do so prior to the installing of equipment and resulting in replacing and/or relocation equipment shall be done at the Contractor's expense.

C. The exact location of all existing utilities and structures and underground utilities are not indicated on the drawings; the Contractor shall determine their locations, and he shall conduct his work so as to prevent interruption of service or damage to them. The Contractor shall protect existing structures and utility services and be responsible for their replacement if damaged by him.

D. Minor adjustments in system layout will be permitted to clear existing fixed obstructions. Final system layout shall be acceptable to Landscape Architect.

1.07 CODES AND STANDARDS:

A. The entire installation shall fully comply with all local and state laws and ordinances and with all established codes applicable thereto.

B. Any permits for the installation of construction of the work included under this contract which are required by any of the legally constituted authorities having jurisdiction, shall be obtained and paid for by the Contractor, each at the proper time. He shall also arrange for and pay all costs in connection with any inspections and examinations required by these authorities.

C. In all cases where inspection of the sprinkler system work is required and/or where portions of the work are specified to be performed under the direction and/or inspection of the Owner's authorized representative, the Contractor shall notify the Owner's authorized representative at least 24 hours in advance of the time and such inspection and/or direction is required.

D. Any necessary re-excavation or alterations to the system needed because of failure of the Contractor to have the required inspections shall be performed at the Contractor's own expense.

1.08 SERVICE AND MAINTENANCE:

A. The Contractor shall service the system during the guarantee period and shall be paid for work performed which is not covered by the guarantee. Contractor shall winterize the system the first year as part of this contract; and shall provide written instructions to the Owner for future service and maintenance.

B. Return to the site during the subsequent spring season and demonstrate to the Owner the proper procedures for the system start-up, operation and maintenance.

C. After completion, testing and acceptance of the system, the Contractor will instruct the Owner's personnel in the operation and maintenance of the system.

1.09 OWNER'S ACCEPTANCE:

A. The completion of the contract will be accepted and Notice of Completion recorded only when the entire contract is completed to the satisfaction of the Owner's authorized representative.

B. Within ten (10) days of the Contractor's notification that the installation is complete, the Owner, or his Representative will inspect the installation and if a final acceptance is not given, will prepare a "Punch List" which, upon completion by the Contractor, will signify acceptance by the Owner.

C. Final payment will not be made without the receipt of an accurate as-built drawing from the contractor.

1.10 WARRANTY:

A. It shall be the Contractor's responsibility to ensure and guarantee satisfactory operation of the entire system and the workmanship and restoration of the area. The entire system shall be guaranteed to be complete and perfect in every detail for a period of one year from the date of its acceptance and he

hereby agrees to repair or replace any such defects occurring within that year, free of expense to the Owner. Minor maintenance and adjustment shall be by Owner.

B. Contractor to guarantee that all trenches and other disturbed areas to be free from heaving or settling more than one-quarter (1/4"). Should it become necessary to adjust the grade, regrade the trench and reseed. This no-settlement clause shall extend over the entire period of guarantee of the job.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General:

1. All materials to be incorporated in this system shall be new and without flaws or defect and quality and performance as specified. All material overages at the completion of the installation are the property of the contractor and are to be removed from the site.

2. The Contractor shall use materials as specified. Material other than specified will be permitted only after written application by the Contractor and written approval by the Landscape Architect. Substitutions will only be allowed when in the best interest of the Owner.

B. Pipe and Fittings:

1. Pipe sizes shall conform to those shown on the drawings submitted by the contractor and approved by the landscape architect. No substitutions of smaller pipe sizes will be permitted, but substitutions of larger size may be approved. All pipe damaged or rejected because of defects shall be removed from the site at the time of said rejection.

2. Provide pipe continuously and permanently marked with manufacturer's name or trademark, size schedule and type of pipe working pressure at 73 degrees F. and National Sanitation Foundation (NSF) approval.

3. All mainline piping and underground piping under continuous pressure plus all pipe 2-1/2” whether a lateral or mainline, shall be rigid, unplasticized polyvinyl chloride pipe extruded from virgin parent material, ASTM D 2241. Provide pipe homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles and dents.

4. Pipe 2-1/2” diameter and under shall be SDR 21, Class 200.

5. Pipe 2-1/2” shall be ring-tite type with push on joint having integral bell end and rubber gasket. Pipe 2” and smaller shall be solvent weld type.

6. PVC pipe fittings for sizes 2-1/2" and smaller shall be ASTM D2466 schedule 40 PVC molded fittings suitable for solvent weld or slip joint ring tite seal. All threaded PVC pipefittings shall be ASTM D2467, Schedule 80 PVC.

7. Size slip fitting socket taper to permit a dry unsoftened pipe end to be inserted no more than halfway into the socket. Saddle and cross fittings are not permitted. Use male adapters for plastic to metal connections. Hand tighten male adapters plus one turn with a strap wrench.

8. All pipes downstream from zone valves sized 2” and smaller, shall be flexible non-toxic polyethylene pipe. Polyethylene pipe shall be ASTM rated at 80 PSI minimum working pressure, and in conformance with ASTM 2239, NSF approved. Pipe larger than 2” size shall be PSI as specified for mainlines. PE 2306 fittings for polyethylene pipe shall be ASTM D2609 insert type fittings. Saddle and cross fittings not permitted. All joints shall be secured with stainless steel band and screw clamps.

9. Primer and solvent for use with PVC pipe to conform to ASTM D2564. Primer to be purple in color. Solvent to be appropriate for pipe and fitting type and weather conditions.

10. All above grade pipe shall be type 'M' copper. Fittings shall be cast brass or wrought copper.

C. Control Wire and Connections:

1. Control wire shall be Type UF, UL approved, for direct burial and shall be Size 14 or larger, as noted on the plans. Conductor to be single strand soft annealed copper.

2. 24 volt control wires to be black or red in color. Common wire to be white in color.

3. Low voltage wire connectors to be made using 3M DBY connectors.

4. 120 volt or heavier splices made underground to be made using 3M DBY connectors.

D. Sprinkler Heads and Valves:

1. Sprinkler equipment shall be as shown on submitted and approved drawings.

F. Valve Boxes:

1. Valve Access Boxes to be tapered enclosure of rigid plastic material comprised of fibrous components chemically inert and unaffected by moisture corrosion and temperature changes. Provide lid of same material black in color. Boxes to be minimum 10" wide and of minimum size required to permit access to the valve. Sidewalls to extend at least 2" below the bottom of valve body; use extension as necessary. Manufacturer to be Ametek.

G. Accessories:

1. Drainage fill: 1/2" x 3/4" washed pea gravel.

2. Fill shall be clean soil free of stones larger than 2" diameter, foreign matter, organic material and debris.

3. Provide imported fill material as required to complete the work. Obtain rights and pay all costs for imported materials.

4. Suitable excavated materials removed to accommodate the irrigation system work may be used as fill material subject to the Landscape Architect's review and acceptance.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine final grades and installation conditions. Do not start irrigation system work until unsatisfactory conditions are corrected.

3.02 PREPARATION:

A. Layout and stake the location of each pipe run and all sprinkler heads and sprinkler valves. Obtain Landscape Architect's acceptance of layout prior to excavating, unless specifically waived by the Landscape Architect.

3.03 EXCAVATING AND BACKFILLING:

A. Excavating shall be considered unclassified and shall include all materials encountered, except materials that cannot be excavated by normal mechanical means. Excavate trenches of sufficient depth and width to permit proper handling and installation of pipe and fittings. Excavate to depths required to provide 2" depth of earth fill or sand bedding for piping when rock or other unsuitable bearing material is encountered.

B. Pipe pulling will be allowed for lateral pipe only, provided soil moisture content and other conditions are suitable to allow for full depth of bury with a minimum of stretching and scraping of the pipe. Landscape Architect reserves the right to determine suitability or conditions. If the pulling method is used, the pipe "plow" shall be a vibratory type.

C. Fill to match adjacent grade elevation with approved earth fill material. Place and compact fill in layers not greater than 8" depth.

D. Provide approved fine-grained earth fill or sand to point 4" above the top of pipe, where soil conditions are rocky or otherwise objectionable.

E. Except as indicated, install irrigation mains with a minimum cover of 18" based on finished grades. Install irrigation laterals with a minimum cover of 14" based on finished grades.

F. Excavate trenches and install piping and backfill during the same working day. Do not leave open trenches or partially filled trenches open overnight.

3.04 UNDERGROUND PIPE:

A. Install plastic pipe in accordance with manufacturer's installation instructions as ASTM D2274. Provide for thermal expansion and contraction.

B. Saw cut plastic pipe. Use a square-in-sawing vice, to ensure a square cut. Remove burrs and shavings at cut ends prior to installation.

C. Make PVC plastic-to-plastic joints with solvent weld joints or slip seal joints. Use only primer and solvent recommended by the pipe manufacturer. Install plastic fittings in accordance with pipe manufacturer's instructions and ASTM D2855. Contractor shall make arrangements with pipe manufacturer for all necessary field assistance.

D. Allow joints to set at least 24 hours before pressure is applied to the system.

E. Maintain pipe interiors free of dirt and debris. Close open ends of pipe by capping, taping or other acceptable method when pipe installation is not in progress.

F. All mainline and continuously pressurized pipe is to be installed using open trenches. Lateral pipe may be installed by "Plowing" if soil conditions permit, and soils do not contain gravel, rock, construction debris or other potential damaging material.

G. Install thrust blocks on the mainline pipe work in accordance with pipe manufacturer's written instructions.

3.05 SPRINKLER INSTALLATION:

A. Install fittings and sprinkler heads in accordance with manufacturer's instructions, except as otherwise indicated.

B. Set sprinkler heads perpendicular to finished grades, except as otherwise indicated, and position to prevent contact with grounds maintenance equipment. Install sprinklers 6" off walks and curbs. Locate sprinkler heads to assure proper coverage of indicated sprinkler heads to assure proper coverage if indicated areas. Do not exceed sprinkler head spacing distances indicated.

C. Provide pop-up spary heads and rotary sprinklers ¾" IPS or smaller with two elbow PVC swing joint riser as shown on drawings.

D. Provide all quick coupling valves with three elbow swing joint, schedule 40 galvanized steel, as detailed on drawings.

3.06 VALVE INSTALLATION:

A. Electric valve installation shall be as indicated on drawings. All electrical and manual valves shall be enclosed in a minimum ten (10) inch width valve box. Add extensions as required to prevent soil settlement around the valve. Set box flush with finish grade and aligned with adjacent boxes and/or adjoining site work.

B. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box. Support box with block or notch box to protect pipe under box.

3.07 DRAINS

A. Although it is intended the system will be winterized using compressed air. Contractor to install manual drain valves at low points in the system to assist in winterization and service.

3.08 ELECTRICAL INSTALLATION:

A. Install electrical control wire in the piping trenches wherever possible. Place wire in trench adjacent to or underneath mainlines but not above. Install wire with slack to allow for thermal expansion and contraction. Expansion joints in wire may be provided at 200 foot intervals by making 5-6 turns of the wire around a piece of 1/2" pipe instead of slack. Where necessary to run wire in a separate trench, provide a minimum cover of 24".

B. Provide minimum 24" slack at remote control valves and at all wire splices to allow raising the valve bonnet or splice to the surface without disconnecting the wires for repair.

C. Connect each remote control valve to one station of a controller except as otherwise indicated. Where there is to be more than one valve per station, make required splice at the control timer.

D. Make splices only at valves, unless otherwise unavoidable. Locate all field splices on the as-built drawing.

3.09 FLUSHING AND TESTING:

A. After all new sprinkler piping and risers are in place and connected for a given section and all necessary division work has be completed, and prior to the installation of sprinkler heads, all control valves shall be opened and a full head of water used to flush out the system.

B. Sprinkler main shall be tested under normal water pressure for a period of 12 hours. If leaks occur, repair and repeat the test. Give Landscape Architect 24 hours notice prior to testing.

C. Testing of the system shall be performed after completion of each section or completion of the entire installation; and any necessary repairs shall be made, at the Contractor's expense, to put the system in good working order before final payment by the Owner.

3.10 CLEAN UP:

A. Contractor shall keep the premises free from rubbish and debris at all times and shall arrange his material storage so as not to interfere with the Owner's operation of the job. Contractor shall remove and legally dispose of all unused material, rubbish and debris, including unsuitable excavated material from the site.

END OF SECTION 322810

SECTION 329200 – SODDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Attention is directed to Bidding and Contract Requirements, and to General and Supplemental Conditions, hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

A. Extent of sodded lawns is shown on drawings and by provisions of this Section.

B. Types of work required include the following:

1. Soil preparation
2. Sodding lawns

C. Related work specified elsewhere:

1. Section 329300: Trees, Plants and Ground Covers
2. Section 329400: Landscape Maintenance and Warranty Standards

1.03 QUALITY ASSURANCE:

A. Sod: Comply with American Sod Producers Association (ASPA) classes of sod materials.
B. Seed Mixture to be specified as an Addendum if Owner chooses Alternate.

1.04 SUBMITTALS:

A. Submit sod growers' certification of grass species including special shade grown species. Identify source location.
B. Manufacturer's certification of fertilizer.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Cut, deliver and install sod within 24-hour period.
B. Do not harvest or transport sod when moisture content may adversely affect sod survival.
C. Protect sod from sun, wind and dehydration prior to installation. Do not tear, stretch or drop sod during handling and installation.

1.06 PROJECT CONDITIONS:

A. Work notifications: Notify Architect at least 7 working days prior to start of sodding operation.
B. Protect existing utilities, paving and other facilities from damage caused by sodding operations.

C. Perform sodding work only after planting and other work affecting ground surface has been completed.
D. Restrict traffic from lawn areas until grass is established. Erect signs and barriers as required.

E. Provide hose and lawn watering equipment as required.

F. An irrigation system will be installed prior to sodding. Locate, protect and maintain the irrigation system during sodding operations. Repair irrigation system components damaged during sodding operations at this Contractor's expense.

1.07 WARRANTY:

A. Refer to Section 02970

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Sod: An "approved" nursery grown blend of improved Kentucky Blue-grass varieties.

1. Sod containing Common Bermudagrass, Quackgrass, Johnsongrass, Poison Ivy, Nutsedge, Nimblewill, Canada Thistle, Timothy, Bentgrass, Wild Garlic, Ground Ivy, Perennial Sorrel or Bramegrass weeds will not be acceptable.

B. Provide well-rooted, healthy sod, free of diseases, nematodes and soil borne insects. Provide sod uniform in color, leaf texture, density and free of weeds, undesirable grasses, stones, roots, thatch and extraneous material; viable and capable of growth and development when planted.

C. Furnish sod machine stripped in square pads or strips not more than 3'-0" long; uniformly 1" to 1-1/2" thick with clean-cut edges. Mow sod before stripping.

D. Fertilizer: Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.

1. Type A: Starter fertilizer containing 20% nitrogen, 12% phosphoric acid and 8% potash by weight or similar approved composition.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine finish surfaces, grades, topsoil quality and depth. Do not start sodding work until unsatisfactory conditions are corrected.

3.02 PREPARATION:

A. Remove all existing sod and debris as described in Specification 329230 (Fine Grading)

B. Limit preparation to areas that will be immediately sodded. Spread topsoil, fine grade. Contractor to provide 1" max. shoveled, beveled edge where lawn areas meet sidewalks and curbs.

C. Treat lawn areas with "Round Up", by Monsanto, per label directions as required to kill existing vegetation prior to sodding.

D. Loosen topsoil of lawn areas to minimum depth of 3". Remove stones over 1" in any dimension and sticks, roots, rubbish and extraneous matter.

E. Grade lawn areas to smooth, free draining and even surface with a loose, and uniformly fine texture. Roll and rake; remove ridges and fill depressions as required to drain.

F. Apply type A fertilizer at the rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (43 lbs./acre). Apply fertilizer by mechanical rotary or drop type distributor, thoroughly and evenly incorporated with the soil to depth of 1" by discing or other approved methods. Fertilize areas inaccessible to power equipment with hand tools and incorporated it into soil.

G. Dampen dry soil prior to sodding.

H. Restore prepared area to specified condition if eroded, settled or otherwise disturbed after fine grading and prior to sodding.

3.03 INSTALLATION:

A. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips. Do not overlay edges. Stagger strips to offset joints in adjacent course. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with adjacent curbs, sidewalks, drains and seeded areas.

B. Do not lay dormant sod or install sod on saturated or frozen soil.

C. Install initial row of sod in a straight line, beginning at bottom of slopes, perpendicular to direction of the sloped area. Place subsequent rows parallel to and lightly against previously installed row.

D. Peg sod on slopes greater than 3 to 1 to prevent slippage at a rate of 2 stakes per yd. of sod.

E. Water sod thoroughly with a fine spray immediately after laying.

F. Roll with light lawn roller to ensure contact with sub-grade.

G. Sod indicated areas within contract limits and areas adjoining contract limits disturbed as a result of construction operations.

3.04 MAINTENANCE:

A. Refer to Section 329400

3.05 CLEANING:

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris and equipment. Repair damage resulting from sodding operations.

END OF SECTION 329200

SECTION 329220 - TOPSOIL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Attention is directed to Bidding and Contract Requirements, General and Supplemental Requirements, which are hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

A. Extent of Topsoil Work is shown on drawings and by provisions of this section and limited to all new and impacted lawn, planting bed, and restoration areas within the site(s).

B. Topsoil for lawn work shall be provided by contractor from off-site sources.

C. Related Work Specified Elsewhere:

1. Section 329220: Sodding
2. Section 329300: Trees, Plants and Ground Covers

1.03 QUALITY ASSURANCE:

A. Testing and inspection: For supplied or stockpiled topsoil. Performed by a qualified independent testing laboratory, under the supervision of a registered professional engineer, specializing in soils engineering. Obtain samples of stockpiled topsoil before complete stripping from the interior of stockpile.

B. Provide and pay for testing and inspection during topsoil operations. Laboratory, inspection services and Soils Engineer shall be acceptable to the Architect.

1. Recommended testing laboratory:
   A & L Agricultural Laboratories, Inc.
   3505 Conestoga Drive
   Fort Wayne, IN 46808
   (219) 483-4759

C. Test representative material samples for proposed use.

D. Topsoil: (Supplied and Stockpiled - See Materials 2.01)

1. pH factor
2. Lime requirement
3. Mechanical analysis (P.K. Ca. mg) and cation ratios
4. Percentage of organic content and loss by ignition
5. Soil series classification
6. Clay content

E. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

F. Submit test reports.

1.04 PROJECT CONDITIONS:

A. Known underground and surface utility lines are indicated on the drawings.

B. Protect existing trees, plants, lawns and other features designated to remain as part of the landscaping work.

C. Promptly repair damage to adjacent facilities caused by topsoil operations. Cost of repair at Contractor's expense.

D. Promptly notify the Architect of unexpected sub-surface conditions.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Topsoil: Supplied or stockpiled topsoil proposed for use must meet testing criteria results specified and conform to adjustments as recommended by soil test and Architect.

B. Existing topsoil: Existing topsoil from on site stockpile shall be utilized. All processing, screening, cleaning and preparation of this stored topsoil to render it acceptable for use is the responsibility of the contractor.

C. Provide additional topsoil as required to complete job. Topsoil must meet testing criteria results specified. All processing, cleaning and preparation of this stored topsoil to render it acceptable for use is the responsibility of this contractor.

D. Supplied or stockpiled topsoil, shall be fertile, friable and representative of local productive soil, capable of sustaining vigorous plant growth and screened free of clay lumps, subsoil, noxious weeds or other foreign matter such as stones greater than 1" in diameter in any dimension, roots, sticks and other extraneous materials: not frozen or muddy. Ph of soil to range between 5.0 and 7.5. Adjusted to 6.0 to 7.5 by additives as required by soil test. Topsoil shall contain not less than 3% and not greater than 10% organic matter. Clay content as determined by Bouyoucous Hydrometer Test shall range between 5 and 15 percent. Mechanical analysis as follows:

PASSING	RETAINED ON	PERCENTAGE
1" Screen	100%	
1" Screen	1/4" screen (gravel)	Not more than 3%
1/4" Screen	No. 140 USS Mesh Sieve	40-60%

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine rough grades and installation conditions. Do not start topsoil work until unsatisfactory conditions are corrected.

3.02 FINISH GRADING:

A. Perform topsoiling within contract limits, including adjacent transition areas, to new elevations, levels, profiles, and contours indicated. Provide uniform levels and slopes between new elevations and existing grades.

B. Grade surfaces to assure areas drain away from building structures and to prevent ponding and pockets of surface drainage.

C. Lawn and planting areas: Supply and spread topsoil to 4" minimum compacted depth in lawn areas or as indicated on drawings.

D. For trees, shrubs, ground cover beds and backfill for beds see Trees, Plants and Ground Cover Section.

E. Provide earth crowning where indicated on drawings.

F. Crowning/mounding to be free flowing in shape and design, as indicated, and to blend into existing grades gradually so that toe of slope is not readily visible.

G. Regardless of finish grading elevations indicated, it is intended that grading be such that proper drainage of surface water will occur and that no low areas are created to allow ponding. Contractor to consult with Owner or Architect regarding minor variations in grade elevations before rough grading is completed.

3.03 CLEANING:

A. Upon completion of topsoiling operations, clean areas within contract limits, remove tools and equipment. Site shall be clear, clean, free of debris and suitable for site work operations.

END OF SECTION 329220

SECTION 329300 - TREES, PLANTS AND GROUND COVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Attention is directed to Bidding and Contract Requirements, and to General and Supplemental Conditions, hereby made a part of this Section.

1.2 DESCRIPTION OF WORK:

A. Extent of trees, plants and ground covers is shown on drawing and by provisions of this Section.

B. Types of work required include the following:

1. Soil preparation
2. Trees, plants and ground covers
3. Planting mixes
4. Mulch and planting accessories
5. Soil percolation tests

C. Related work specified elsewhere:

1. Section 329220: Topsoil
2. Section 329200: Sodding
3. Section 329400: Landscape Maintenance and Warranty Standards

1.3 QUALITY ASSURANCE:

A. Plant names indicated, comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.

B. Comply with sizing and grading standards of the latest edition of “American Standard for Nursery Stock". A plant shall be dimensioned as it stands in its natural position.

C. All plants shall be nursery grown under climatic conditions similar to those in the locality of the project for a minimum of 2 years.

D. Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable, at no additional charge. Larger plants shall not be cut back to size indicated.

E. Provide "specimen" plants with a special height, shape or character of growth. Contractor to tag specimen trees or shrubs at the source of supply. The Architect will inspect specimen selections at the source of supply for suitability and adaptability to selected location. When specimen plants cannot be purchased locally, provide sufficient photographs of the proposed specimen plants for approval. The

Contractor shall inspect all plant material at source prior to Architect's approval. Contractor shall accompany Architect on final selection trip.

F. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.

G. Provide percolation testing by filling plant pits with water and monitoring length of time for water to completely percolate into soil. Submit test results to architect prior to starting work.

1.4 SUBMITTALS:

A. Submit the following material samples:

1. Shredded bark mulch.

B. Submit the following materials certification:

1. Topsoil source and pH value
2. Plant fertilizer

1.5 DELIVERY, STORAGE AND HANDLING:

A. Deliver fertilizer materials in original, unopened and undamaged containers showing weight, analysis and name of manufacturer. Store in manner to prevent wetting and deterioration.

B. Take all precautions customary in good trade practice in preparing plants for moving. Workmanship that fails to meet the highest standards will be rejected. Spray deciduous plants in foliage with an approved "Anti-Dessicant" immediately after digging to prevent dehydration. Dig, pack, transport and handle plants with care to ensure protection against injury. Inspection certificates required by law shall accompany each shipment invoice or order to stock and on arrival. A copy of certificate shall be filed with the Architect. Protect all plants from drying out. If plants cannot be planted immediately upon delivery, properly protect them with soil, wet peat moss or in a manner acceptable to the Architect. Water heeled-in plantings as required to keep root system moist until planting. No plant shall be bound with rope or wire in a manner that could damage or break the branches.

C. Cover plants transported on open vehicles with a protective covering to prevent windburn.

D. Frozen or muddy topsoil is not acceptable.

1.6 PROJECT CONDITIONS:

A. Work Notification: Notify Architect at least 7 working days prior to installation of plant material.

B. Protect existing utilities, paving and other facilities from damage caused by landscaping operations. See AIA General Conditions.

C. A complete list of plants, including a schedule of sizes, quantities and other requirements is shown on the proposal form. In the event that quantity discrepancies or material omissions occur in the proposal form, Contractor shall notify the Architect during the proposal bidding process.

D. An irrigation system will be installed prior to planting. Locate, protect and maintain the irrigation system during planting operations. Repair irrigation system components, damaged during planting operations, at this Contractor's expense.

E. Perform percolation testing.

F. Verify availability of on-site water.

G. Concealed contingencies. Refer to AIA General Conditions.

1.7 WARRANTY:

A. Refer to Section 329400.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Plants: Provide plants typical of their species or variety; with normal, densely developed branches and vigorous, fibrous root systems. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sunscald injuries, frost cracks, abrasions of the bark, plant diseases, insect eggs, borers and all forms of infestation. All plants shall have a fully developed form without voids and open spaces.

1. Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Provide ball sizes complying with the latest edition of the "American Standard for Nursery Stock". Cracked or mushroomed balls are not acceptable.

2. Provide tree species that mature at heights over 25'-0" with a single, main trunk. Trees that have the main trunk forming a "Y" shape are not acceptable.

3. Plants planted in rows shall be matched in form. (See specimen stock).

4. Plants larger than those specified in the plant list may be used when acceptable to the Architect.

5. If the use of larger plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.

6. The height of the trees, specified by height, measured from the crown of the roots to the top of the top branch, shall not be less than the minimum size designated in the proposal form.

7. No pruning wounds shall be present with a diameter of more than 1" and such wounds must show vigorous bark on all edges.

8. Evergreen trees shall be unsheared and branched to the ground.

9. Shrubs and small plants shall meet the requirements for spread and height indicated on the proposal form.

B. Container-grown Stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.

1. No plants shall be loose in the container.

2. Container stock shall not be root bound.

3. The measurements for height shall be taken from the ground level to the average height of the top of the plant and not the longest branch.

4. Single stemmed or thin plants will not be accepted.

5. Side branches shall be generous, well-twigged and the plant as a whole well-bushed to the ground.

6. Plants shall be in a moist, vigorous condition, free from dead wood, bruises or other root or branch injuries.

C. Specimen Stock: All specimen-designated plantings are to be nursery grown, fully developed, excellent quality and typical example of the species. Plants designated to be planted in rows must be matched, symmetrical and uniform in height, spread, caliper and branching density.

1. Matched plantings should be obtained from same nursery and, preferably, from same row or line. All specimen material will be approved by Architect at nursery.

D. Topsoil for Planting Mix: Refer to Section 329220.

E. Peat Moss: Brown to black in color, weed and seed free granulated raw peat.

1. Provide ASTM D 2607 sphagnum peat moss with a PH below 6.0 for ericaceous plants.

F. Planting Mixture Type A: Standard planting backfill shall be a mixture of 1/3 topsoil, 1/3 sand and 1/3 peat per cubic yard of mixture. Add fertilizer Type "A" to planting mixture per manufacturer's requirements. Follow planting details.

G. Planting Mixture Type B (for Flowers, Ground Cover Beds, Ericaceous Plants and Ornamental Grasses): Planting backfill shall be a mixture of 1/3 topsoil, 1/3 sand and 1/3 peat. Adding fertilizer type "B" to mixture per manufacturers requirements. Follow planting details.

H. Plant Fertilizer Type A: "Scotts Pro Grow 18-3-6 landscape fertilizer plus minors, applied per manufacturer's recommendations.

I. Plant Fertilizer Type B: Approved acid-base fertilizer; "Espoma Holly-Tone". 4-6-4 applied per manufacturer's instructions.

J. Superphosphate: Composed of finely ground phosphate rock as commonly used for agricultural purposes containing not less than eighteen 18%) percent available phosphoric acid. Apply as required based upon soil test report.

K. Lime: Ground dolomitic limestone, ninety-five (95%) percent passing through #100 mesh screen. Use to adjust soil pH only, under direction of Architect or based upon soil test report.

L. Sand: Clean, coarse, ungraded conforming to ASTM C 3 for fine aggregates.

M. Anti-Dessicant: Protective film emulsion providing a protective film over plant surfaces; permeable to permit transpiration. Mixed and applied in accordance with manufacturer's instructions.

N. Shredded Bark Mulch: Clean, free of debris and sticks, and well aerated. Materials shall be uniform in size, shape and texture. Submit samples to owner for approval prior to installation. Install mulch to finish grade, level smooth, without ridges, humps or depressions.

O. Water: Free of substances harmful to plant growth. Hoses or other methods of transportation furnished by Contractor.

P. Stakes for Staking: Hardwood, 2" x 2" x 6'-0" minimum length.

Q. Stakes for Guying: Hardwood, 2" x 2" x 36" long.

R. Guying/Staking Wire: No. 11 gauge galvanized wire.

S. Turnbuckles: Galvanized steel of size and gauge required to provide tensile strength equal to that of the wire. Turnbuckle opening shall be at least 3".

T. Staking and Guying Hose: Two-ply, reinforced garden hose not less than 1/2" inside diameter.

U. Tree Wrap: Standard waterproofed tree wrapping paper, 2-1/2" wide, made of 2 layers of crepe kraft paper weighing not less than 30 lbs. per ream, cemented together with asphalt.

V. Twine: Two-ply jute material.

W. Steel Edging: 3/16" x 4" Ryerson with interlocking joints and steel stakes. Install per manufacturer's recommendations. Top to be flush with finish grade, alignment per drawings. All edging to be new. Telephone (313) 874-3311, Detroit, Michigan.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine proposed planting areas and conditions of installation. Do not start planting work until unsatisfactory conditions are corrected.

3.2 PREPARATION:

A. Time of planting:

1. Evergreen material: Plant evergreen materials between August 15 and October 1 or in spring before new growth begins. If project requirements require planting at other times, plants shall be sprayed with anti-dessicant prior to planting operations.

2. Deciduous material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in-leaf, they shall be sprayed with an anti-dessicant prior to planting operation.
3. Planting times other than those indicated shall be acceptable to the Architect.

B. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.

C. Individual plant locations shall be staked on the project site by the Contractor and approved by the Architect before any planting pits are dug. The Architect reserves the right to adjust plant material locations to meet field conditions, without additional cost to the Owner.

D. Planting pits shall be round, with vertical sides and flat bottoms and sized in accordance with outlines and dimensions shown on the planting details.

E. Accurately stake plant material according to the drawings. Stakes shall be above grade and painted a bright color to be clearly visible for inspection.

F. If obstructions are encountered that are not indicated, do not proceed with planting operations until alternative plant locations have been selected and approved in writing by the Architect. Where location or spacing dimensions are not clearly shown, request clarification by the Architect.

G. See drawings for planting details.

H. Vegetation Removal:

1. Strip existing grass and weeds, including roots, from all bed areas, till and fine grade existing topsoil, leaving the soil surface one-inch below finished grade (in areas shown on plan).

2. Herbicide: Use Round Up (Monsanto Co.) as required to prepare areas for new planting, applied to all ground cover, evergreen and shrubbery beds and all mulch areas before application of pre-emergence herbicide, per manufacturer's recommendations. Clean area of all dead material after five (5) days.

3. Pre-Emergence Herbicide: DACTHAL W-75 (Diamond Shamrock Agricultural Chemicals) applied to one (1) ounce per l00 square feet to same area where "Herbicide" has been applied and after area is cleared of dead vegetation.

4. Herbicides to be applied by licensed applicator as required by the state.

3.3 INSTALLATION:

A. Excavate circular plant pits with vertical sides, except for plants specifically indicated to be planted in beds. Provide plant pits per planting details. Depth of pit shall accommodate the root system. Scarify the bottom of the pit to a depth of 4".

B. Provide pre-mixed planting mixture Type "A" for use around the balls and roots of all deciduous and evergreen tree plantings.

C. Beds for Ground Cover, Flowers, Ericaceous Plants and Ornamental Grasses: Excavate existing soil to 12" depth over entire bed area and remove soil from site. Set plants according to drawings and backfill entire bed with pre-mixed planting mixture Type "B".

D. Planting:

1. Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb and faced to give the best appearance or relationship to each other or adjacent structure. Set plant material 2"-3" above the finish grade. No filling will be permitted around trunks or stems. Backfill the pit with planting mixture. Do not use frozen or muddy mixtures for backfilling. Form a ring of soil around the edge of each planting pit to retain water in non-irrigated areas.

2. After balled and burlapped plants are set, muddle planting soil mixture around bases of balls and fill all voids. Sufficiently compact to prevent settlement.

3. Remove all burlap, ropes and wires from the tops of balls.

4. Space ground cover plants in accordance with indicated dimensions. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants. Plant to within 12" of the trunks of trees and shrubs within planting bed and to within 6" of edge of bed.

5. Spread and arrange roots of bare-rooted plants in their natural position. Work-in planting mixture. Do not mat roots together. Cut all broken and frayed roots before installing planting mixture.

6. Water immediately after planting.

F. Mulching:

1. Mulch tree and shrub planting pits and shrub beds with required mulching material 3" deep immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.

G. Wrapping, Guying, Staking:

1. Inspect trees for injury to trunks, evidence of insect infestation and improper pruning before wrapping.

2. Wrap trunks of all trees spirally from bottom to top with specified tree wrap and secure in place.

3. Stake/guy all trees immediately after lawn seeding or sodding operations and prior to acceptance. When high winds or other conditions that may effect tree survival or appearance occur, the Architect shall require immediate staking/guying.

4. Stake deciduous trees under 4" caliper. Stake evergreen trees under 12'-0" tall with 2 x 2 cedar stakes, 2 per tree.

5. Guy deciduous trees 4" caliper and over. Guy evergreen trees 12'-0" tall and over with metal fence post, 3 per tree.

6. All work shall be acceptable to the Architect.

H. Pruning:

1. Prune branches of deciduous stock, after planting, to balance the loss of roots and preserve the natural character appropriate to the particular plant requirements. Remove or cut back broken, damaged and unsymmetrical growth of new wood.

2. Multiple leader plants: Preserve the leader that will best promote the symmetry of the plant. Cut branches flush with the branch collar. Make cut on an angle.

3. Prune evergreen trees only to remove broken or damaged branches.

3.4 CLEANING:

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris and equipment. Repair damage resulting from planting operations.

END OF SECTION 329300

SECTION 329400 - LANDSCAPE MAINTENANCE AND WARRANTY STANDARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Attention is directed to Bidding and Contract Requirements, and to General and Supplemental Conditions, hereby made a part of this Section.

1.02 DESCRIPTION OF WORK:

A. The requirements of this section include a one-year warranty period from date of acceptance of installation.

B. Related Work Specified Elsewhere:

1. Section 329220: Topsoil
2. Section 329200: Sodding
3. Section 329300: Trees, Plants and Ground Covers

1.03 ACCEPTANCE OF INSTALLATION:

A. At the completion of all landscape installation, or pre-approved portions thereof, the Contractor shall request in writing an inspection for acceptance of installation in which the Contractor, Architect and Owner's Representative shall be present. After this inspection a "Punch List" will be issued by the Architect and/or Owner's Representative. After completion of punch list items, the Architect, Contractor and Owner's Representative shall re-inspect the project and upon satisfactory completion of punch list items, issue a written statement of acceptance of installation and establish the beginning of the project warranty period.

B. It is the responsibility of the Contractor to make the above written request for inspection of installation in a timely fashion. If there is plant material loss prior to the Contractor's written request for inspection of installation, the Contractor shall make all replacements of this dead material at no additional cost. These replacements are not considered to be the required one (1) replacement of dead plant material by the Contractor during the one (1) year project warranty period, as outlined below.

C. Landscape work may be inspected for acceptance in parts agreeable to Owner's Representative and Architect provided work offered for inspection is complete, including maintenance as required.

D. For work to be inspected for partial acceptance, supply a written statement requesting acceptance of this work completed to date.

1.04 PROJECT WARRANTY:

A. The project warranty period begins upon written acceptance of the project installation by Architect and Owner's Representative.

B. The contractor accepts responsibility for the irrigation system operation, watering schedule, watering amounts and monitoring system for duration of maintenance and warranty period.

C. The Contractor shall guarantee trees, shrubs, ground cover bed, and seeded or sodded areas through construction and for a period of one year after date of acceptance of installation against defects including death and unsatisfactory growth, except for defects resulting from neglect by owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Contractor's control.

D. The Contractor shall warranty plants due to over watering or under watering by automatic irrigation system during maintenance and warranty period.

1.05 MAINTENANCE

A. To ensure guarantee standards, the following maintenance procedures shall be executed during construction and for the full project warranty period.

B. Maintenance of Trees, Shrubs and Ground Covers:

1. Contractor shall be responsible for replacement of any plant materials after project acceptance date, see Section 1.03, that are dead or in the opinion of the Architect are in an unhealthy or unsightly condition, or having lost natural shape, resulting from die back, excessive pruning, excessive or deficient watering practices, or inadequate or improper maintenance as part of the guarantee. Prior to any replacements Contractor shall review individual plants in question with Architect and determine the reason for plant demise.

2. Replacements must meet specifications i.e. quality, species of plant material and planting procedures to receive approval of replacement materials by Architect.

3. Costs for replacements are assumed part of bid quotations and therefore will not result in an additional cost to Owner or Architect.

4. Areas damaged as result of replacement operations are to be restored by Contractor at no cost to the Owner or Architect.

5. The Contractor shall be responsible for keeping guy wires taut, raise tree balls that settle, furnish, and apply sprays as necessary to keep the plantings free of disease and insects until the end of the warranty period. All evergreens shall be watered thoroughly, and wilt proofed in the fall to insure they do not go into the winter dry.

6. Winter Evergreen Protection (Trees and Shrubs): Treated burlap (green) and 2' x 2' x 8' hardwood stakes @ 4'-0" O.C. Attach burlap with wood lath and roofing nails. Contractor shall erect, remove, and deliver to owner. Contractor shall install winter protection the first winter, install December 1 and remove April 15. Install screen height as required. Spray evergreens with wiltproof prior to December 1 and again January 1, two coatings are required.

7. The Contractor shall be responsible for watering of all plantings throughout construction, maintenance, and warranty periods.

8. The Contractor will be responsible for irrigation system operation, watering schedules, watering amounts and general monitoring of irrigation system throughout construction, maintenance, and warranty period if an irrigation system is in place. If no irrigation system is in place, Contractor is

responsible for monitoring and applying manual watering. Over watering or lack of, from irrigation system source is the responsibility of the contractor.

9. Remove and replace trees, shrubs, or other plants found to be dead or in unhealthy condition. Remove rejected plants and materials promptly. Make replacements during following normal planting schedule. Replace trees and shrubs which are in doubt, unless, in opinion of Owner's Representative and Architect it is advisable to extend warranty period for a full-growing season. Remove all stakes, guy wires, tree wrap paper, dead twigs and branches from tree and plant materials at the end of this warranty period. Keep planting beds free of weeds during guarantee period. See Trees, Plants and Ground Covers Section for suggested herbicides.

C. Maintenance of Sodded and Seeded Lawn Area:

1. Maintain sodded and seeded lawn areas, including watering, fertilizing, spot weeding, application of herbicides, fungicides, insecticides, and resodding until a full, uniform stand of lawn is knitted to topsoil.

2. Water sod thoroughly, as required to establish proper rooting. Water seed as required per mixture requirements for optimum establishment.

3. Repair, rework and resod all areas that have washed out or are eroded. Replace undesirable or dead areas with new sod. For seeded lawns, reseed any areas that are bare or weedy.

4. Provide a uniform stand of grass by watering, mowing, and maintaining lawn areas until acceptance of installation. Resod areas, with specified materials, which fail to provide a uniform stand of grass until all affected areas are accepted by Architect.

5. Mow lawn areas as soon as lawn top growth reaches a 3" height. Cut back to 2" height. Repeat mowing as required to maintain specified height. Not more than 40% of grass leaf shall be removed at any single mowing. Minimum of two cuttings.

6. Sodded or seeded areas will be acceptable provided all requirements, including maintenance, have been complied with, and a healthy, even colored viable lawn is established, free of weed, undesirable grass species, disease, and insects.

7. After acceptance of installation, and for the duration of the project warranty period of the Contractor shall continue all maintenance procedures including fertilizing, except for mowing, weeding, rolling, regrading, resodding and applying herbicides, fungicides, insecticides as required to establish a smooth acceptable lawn, free of eroded or bare areas.

8. At Conclusion of project warranty period and after receiving written final acceptance by Owner's Representative and Architect, the Owner shall assume all sodded or seeded lawn maintenance responsibilities.

1.06 FINAL ACCEPTANCE:

A. At the conclusion of the project warranty period the Contractor shall request a project inspection for final acceptance in which the Contractor, Architect and Owner's Representative shall be present. After this inspection a "Punch List" will be issued by the Architect. Upon completion of all punch list items, the Architect and Owner's Representative shall reinspect the project and issue a written statement of final acceptance. Upon final acceptance the Owner assumes all maintenance responsibilities for the project.

PART 2 AND 3 - PRODUCTS AND EXECUTION

Not Applicable.

END OF SECTION 329400

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Channel drainage systems.
3. Encasement for piping.
4. Manholes.
5. Cleanouts.
6. Nonpressure transition couplings.
7. Expansion joints.
8. Catch basins.
9. Stormwater inlets.
10. Pipe outlets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins: Include plans, elevations, sections, details, frames, covers, and grates.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F 477, elastomeric seals.

2.2 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).

1. Tongue-and-Groove ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets
2. Class IV.

2.3 NONPRESSURE TRANSITION 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:

1. Description: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Description: 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.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.4 CLEANOUTS

A. Plastic Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. In accordance with the City of Warren Standard Specifications and current MDOT Standard Specifications.
2. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to

indicated elevation and slope. Include sealant recommended by ring manufacturer. Minimum of two rings per structure.

B. Manhole Frames and Covers:

1. Storm Manhole Frame and Cover: EJ 1040 Type B Cover, as required.

2.6 CATCH BASINS

A. Standard Precast Concrete Catch Basins w/ two foot sumps:
1. In accordance with the City of Warren Standard Specifications and current MDOT Standard Specifications.
2. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer. Minimum of two rings per structure.

B. Frames and Grates:

1. Pavement Catch Basin Frame and Cover: EJ 5080 Type M-1 Cover, as required.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 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 into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping as shown on the plans.
3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
4. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
   2. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 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 Heavy-Duty, top-loading classification cleanouts.

B. Set cleanout frames and covers where shown on the plans.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.

3.6 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

3.7 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) 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. Damage: 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. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 334100

SECTION 334200 - UNDERGROUND DETENTION AND INFILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Underground Detention and Infiltration System.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include site layout drawings, sections and details.

2. Hydraulic storage data with supporting calculations.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall have been regularly engaged in the engineering design and production of these systems for at least ten (10) years and which has a history of successfully completing similar type projects.

B. Installer Qualifications: An entity that employs qualified installers and supervisors who have a history of successfully completing similar type projects.

1.6 REFERENCED STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO).
1. AASTHO Design Section 12 – Soil-Corrugated Metal Structure Interaction Systems.
2. AASHTO Construction Section 26 – Metal Culverts.
3. AASHTO M36 – Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
4. AASHTO M274 – Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe.

B. American Society of Testing and Materials (ASTM).
   1. ASTM A760: Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
   2. ASTM A929: Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.
   3. ASTM A798: Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
   4. ASTM A998: Standard Practice for Structural Design of Reinforcements for fittings in Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide Underground Detention and Infiltration System manufactured by “Contech Engineered Solutions” or similar products by other manufacturers that meet requirements.

2.2 MATERIALS

A. Aluminized Type II material shall conform to the applicable requirements of AASHTO M274 or ASTM A929. CMP shall be manufactured in accordance with the applicable requirements of AASHTO M36 or ASTM A760.

B. The pipe sizes, gauges and corrugations shall be as shown on the project plans. Joint performance requirements are published in Division II, Section 26.4.2, of the current edition of the AASHTO Bridge Construction Specifications.

C. Soil tight, gravity flow, non-pressure, drainage pipe joints shall conform to AASHTO M36 and ASTM A760. Minimum joint spacing shall be 10 ft.

D. Overlapping of adjacent pipes are not permitted and appropriate banding must be utilized in order to properly secure individual pipes in place.

E. Integral End Sections: Each barrel of the CMP System shall either be connected to a fitting composing a manifold for hydraulic distribution or have an integrated bulkhead to resist loading at the end/start of the barrel, end cap sections shall not be permitted.

F. Material selected shall be flame resistant and capable of retaining 80% of strength when subjected to a temperature of 400 degrees Fahrenheit for one hour.

G. All fittings shall be manufactured prior to arriving on the jobsite to ensure structural integrity. Fitting reinforcement shall be in accordance with ASTM A998 and reinforcing details. Bulkhead design and fabrication does not vary with differing coatings on the steel components.

2.3 PERFORMANCE REQUIREMENTS

A. The CMP System shall be sized in accordance to the design provided and approved by the Engineer of Record (EOR). Any Contractor deviating from the design shown on the plans, to include: material, footprint, etc., shall provide to the EOR a summary report on stage-storage curves, design calculations, HydroCAD modeling and engineering drawings.

B. The CMP System shall comprise of manhole access with minimum dimensions of 24 inches diameter to provide adequate inspection and maintenance without restrictions and obstructions to entry into interior of the CMP System. Manholes shall be provided to allow full entry into and visual inspection of the complete CMP System, at a minimum as to allow full maintenance of the CMP System. Cleanouts or inspection ports are not acceptable access points for maintenance and inspection nor are any other alternatives which do not allow for full entry into the system.

C. The CMP System shall be designed for a minimum HS-20/HS-25 final live loading conditions. The CMP System shall meet HS-20/HS-25 loading requirements with a minimum of 12-inches of cover to bottom of flexible pavement for pipe spans less than or equal to 96 inches and 18 inches of cover to bottom of flexible pavement for pipe spans greater than 96 inches.

D. The CMP System shall be designed so as the hydraulic grade line will increase evenly throughout whereas transverse movement from one storage compartment to another shall not be permitted. All storage compartments shall be connected via manifold (or connecting pipe) versus by transporting stormwater through stone.

E. A stormwater pretreatment device shall be provided upstream of the CMP system as follows:
   1. Infiltration: Where feasible, the selected stormwater treatment device upstream of an infiltration system shall be a filter system and have General Use Level Designation (GULD) for Basic Treatment by the Washington State Department of Ecology or demonstrate equivalent performance in independently verified field testing following a peer reviewed testing protocol, and must be sized consistent with the system producing those results.
   2. Detention: Where feasible, the selected Stormwater treatment device upstream of a detention system shall be a separator system and have GULD for Pretreatment by the WADOE or demonstrate equivalent performance in independently verified field testing following a peer reviewed testing protocol, and must be sized consistent with the system producing those results.
   3. Selected pretreatment stormwater device shall incorporate a physical barrier capable of capturing and retaining trash and debris (i.e.: floatable and neutrally buoyant materials) for all flows up to the treatment capacity of the device.
   4. The application of wrapping a system with geotextile of any branding or material type, that allows the passage of stormwater, shall not be regarded as an acceptable treatment or pretreatment device.
   5. In order to not restrict the Owner's ability to maintain the stormwater pretreatment device, the minimum dimension providing access from the ground surface to the sump chamber shall be 20 inches in diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The CMP System installation shall be in accordance with AASHTO Standard Specifications for Highways Bridges, Section 26, Division II or ASTM A798 and in conformance with the project plans and specifications.

B. The CMP System shall be installed in accordance with the manufacturer's recommendations and related sections of the contract documents. Handling & assembly shall be in accordance with National Corrugated Steel Pipe Association's (NCSPA) recommendations.

C. For temporary construction vehicle loads, an extra amount of compacted cover may be required over the top of the pipe. The Height-of-Cover shall meet the minimum requirements shown in the table below. The use of heavy construction equipment necessitates greater protection for the pipe than finished grade cover minimums for normal highway traffic.

Minimum Cover (ft) Requirements

Pipe Span (inches)	Axle Loads (kips)			
	18 - 50	50 - 75	75 - 110	110 - 150
12 - 42	2.0	2.5	3.0	3.0
48 - 72	3.0	3.0	3.5	4.0
78 - 120	3.0	3.5	4.0	4.0
126 - 144	3.5	4.0	4.5	4.5

D. Minimum cover may vary, depending on local conditions. The contractor must provide the additional cover required to avoid damage to the pipe. Minimum cover is measured from the top of the pipe to the top of the maintained construction roadway surface.

E. Backfill material shall be placed in 8 inch loose lifts and compacted to 90% AASHTO T99 standard proctor density.

END OF SECTION 334200