

SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 REGULATORY REQUIREMENTS

- A. The GENERAL CONDITIONS and GENERAL REQUIREMENTS are made a part of this Section. Work under this Section includes all work necessary for effective soil erosion and sedimentation control in conformance with Part 91, Act 451, PA 1994, the Soil Erosion and Sedimentation Control Act.
- B. Rules, regulations or laws of any controlling governmental agency shall govern when they are more stringent than the requirements of this Section.
- C. All earth changes shall be made in such a manner as to minimize the area of disturbed land exposed and unprotected against erosion and the duration of such exposure.
- D. Sediment caused by accelerated soil erosion shall be restricted to a non-polluting minimum (as determined by the agency designated in accordance with and having jurisdiction and responsibility for the enforcement of sedimentation control).
- E. All sedimentation control measures shall be maintained in an operating condition satisfactory to the designated agency, for the period of time which that agency deems necessary. This provision applies to all facilities that directly receive waters from the earth-change area, whether such facilities are a part of the proposed construction or existed prior to proposed construction.
- F. Temporary stabilization measures shall be repeated when, and as often as, required by the aforementioned agency.
- G. Any facility constructed for the conveyance of water around, through or from the earth-change area shall limit the water flow to a non-erosive velocity.
- H. Temporary sedimentation control devices and facilities shall be removed upon completion of the primary construction. The land surface area formerly occupied by such facilities shall then be graded and restored in accordance with the Plans and Specifications.
- I. Obtain all pertinent permits including a Soil Erosion Control Permit from the County or local enforcing agency. Submit an NPDES Notice of Coverage, if required, when the soil erosion permit is received.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Straw bales and mulch shall be clean wheat straw or marsh hay. Straw shall be clean and free of weeds and weed seed. Hay will be allowed only when straw is not available. Bales are to be standard rectangular shape held together with 2 strands of hemp rope.
- B. Sediment control / silt fence shall be a geotextile filter fabric capable of containing sediment, attached to wooden stakes capable of supporting the geotextile fabric.
- C. Acceptable geotextile catch basin filter wrap.
- D. Contractor shall provide temporary culverts to maintain ditch drainage.

PART 3 EXECUTION

3.01 CONSTRUCTION SEQUENCE

- A. To minimize the area of un-stabilized land surface over which storm waters must flow, construction shall proceed from lower ground toward higher ground whenever possible.

3.02 TEMPORARY STOCKPILES

- A. The Contractor shall take steps to prevent, or contain on-site, erosion from material stockpiles.

3.03 SEDIMENTATION CONTROL

- A. The Contractor shall provide a suitable temporary sedimentation control facility at any connection to an existing enclosed storm drain, to minimize deposition of sediment in the existing storm drain during construction.
- B. To prevent sediment from entering existing storm drains during the construction period, the Contractor shall provide suitable control facilities around storm water inlet facilities.
- C. All open ditches and natural watercourses intercepted by the proposed construction shall be temporarily re-routed, provided with temporary sedimentation control facilities within their cross-section, and/or diverted into a newly-established drain via non-erosive channels.
- D. Temporary sedimentation control devices and/or facilities shall be designed on the Plans. Modifications to the Plan requires prior approval of the Engineer and local permitting agency.
- E. In all cases, such facilities, whether permanent or temporary, shall be provided prior to any significant clearing, grading, or surface disruption of the tributary area.

3.04 DEWATERING

- A. Pumped water from well points or dewatering wells installed to lower the water table to facilitate the proposed construction shall not discharge onto un-stabilized areas. Such discharge shall be conveyed by pipe, hose, or stabilized channel to a settling basin or other suitable sedimentation control facility.

3.05 VEHICULAR CONTROLS

- A. Employ suitable cleaning methods to minimize the transfer of sediment-producing materials from the wheels of the vehicles onto adjacent improved surfaces. Contractor shall keep adjacent roads free of debris.

3.06 RESTABILIZATION OF TERRAIN

- A. Final cleanup shall leave the property in as good or better condition than it was at the beginning of construction. Cleanup operations including at least rough grading and temporary stabilization shall be started as soon as feasibly possible where:
 - 1. pipe is laid in any location;
 - 2. one acre or more of the ground surface is brought to its approximate proposed elevation, in an earth excavation, mining, landfilling, mass grading, or land balancing project; or
 - 3. of substantial completion of the base, the curb, or the curb and gutter, whichever first occurs, in a road, street, highway, parking area or sidewalk

construction project; and shall be completed within the next fifteen (15) days.

- B. Temporary stabilization applied during freezing weather shall consist of hay or straw mulch applied at the rate of 2 tons per acre, "tacked" in place by locally approved methods. Temporary stabilization applied during other than freezing weather shall consist of perennial rye grass applied at the rate of 25 pounds per acre with hay or straw mulch applied at the rate of 2 tons per acre, "tacked" in place with locally approved methods.
- C. Temporary stabilization shall be provided during the non-growing season for all areas to be seeded / sodded. This time period is generally from October 15 through April 15, both inclusive.
- D. Temporary stabilization shall be provided for all uncompleted areas where significant earth disruption ceases for more than 30 days.
- E. All areas which have been temporarily stabilized shall be permanently stabilized no later than 30 days following commencement of the planting season immediately following substantial completion of construction.
- F. All mulch used for temporary stabilization shall be removed prior to permanent stabilization.
- G. Permanent Stabilization is hereby defined as the Work described elsewhere in the Specifications.

3.07 CONTRACTOR'S GENERAL RESPONSIBILITY

- A. The Contractor shall be responsible for the proper implementation of the "Soil Erosion and Sedimentation Control Plan" as a part of this Contract. If a Soil Erosion and Sedimentation Control plan is supplied in the project drawings, the Contractor shall install the proposed Soil Erosion and Sedimentation Control measures per the plan.
- B. If a plan is not supplied, it is the responsibility of the Contractor to meet all local and state ordinances. A regular inspection program and a thorough maintenance program shall be developed and implemented by the Contractor to insure the effectiveness of the erosion and sedimentation control practices.

END OF SECTION

SECTION 03 05 10
CONCRETE COLOR ADDITIVES AND FINISHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Requirements For Color Additive Used In:
 - 1. Portland cement concrete paving specified in Section 32 13 13.
 - 2. Cast-in-place concrete specified in Section 03 30 00.
 - 3. Cast-in-place concrete specified in Section 03 30 00.01.
 - 4. Exposed aggregate concrete specified in Section 03 35 00.

1.2 RELATED SECTIONS

- A. Section 07 90 00 - Joint Protection: Colored sealants for joints.

1.3 REFERENCES

- A. ASTM C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; American Concrete Institute.
 - B. ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete.
 - C. For concrete: ACI 301, ACI 304, ACI 305R, ACI 306R, ACI 318.
 - D. For paving: ACI 316R.
- PCA PA124.H - Finishing Concrete Slabs with Color and Texture.
PCA SP021A - Color and Texture in Architectural Concrete.

1.4 SUBMITTALS

- A. Submit under the provisions of Section 01 30 00.
- B. Product Data : Manufacturer's specifications and instructions for color additives and curing compounds.
- C. Samples for Verification of Concrete Color: Sample chips of specified colors indicating color additive numbers and required dosage rates. Submittals are for general verification of color and may vary somewhat from concrete finished in field according to Specifications.
- D. Samples of Aggregate and Sand.
- E. Curing Compound
- F. Samples of Form Facing Materials: Coordinate submittal with materials specified in Section 03 30 00 and Section 03 30 00.01.
- G. Samples of Surface Retarder: Coordinate submittal with materials specified in Section 03 30 00 and Section 03 30 00.01 and Section 32 13 13.
- H. Samples of Form Release Agents: Coordinate submittal with materials specified in Section 03 30 00 and Section 03 30 00.01.

1.5 QUALITY ASSURANCE

**** NOTE TO SPECIFIER **** Specify preconstruction conference if job is complex.

- A. Mock-Up: Provide full-scale mock-up to demonstrate methods of obtaining consistent visual appearance.
 - 1. Coordinate mock-up requirements with mock-ups specified in other sections; same mock-up may be used for more than one purpose.
 - 2. Construct at least one month before the start of actual work, using materials and methods to be used in actual work.
 - 3. Paving: [3] - 10 by 10 feet mockups showing colors and finishes.
 - 4. Locate mock-up on site.
 - 5. Retain samples of materials used in mock-up for comparison with materials used in remaining work.
 - 6. Accepted mock-up constitutes a visual standard for work.
- B. Remove mock-up when no longer required for comparison with finished work.
- C. Manufacturer Qualifications: Manufacturer with 10-years experience in the production of specified products.
- D. Installer Qualifications: An installer with 5 years' experience with work of a similar scope and quality.
- E. Comply with the requirements of ACI 301.
- F. Obtain each specified material from same source and maintain high degree of consistency in workmanship throughout Project.
- G. Notification of manufacturer's authorized representative shall be given at least 1-week before start of Work.
- H. Preconstruction Conference: Conduct a review of procedures required to produce specified results.

1.2 DELIVERY, STORAGE, AND HANDLING

- A. Color Additives: Comply with manufacturer's instructions. Deliver to site or batch plant in original, unopened packaging. Store in dry conditions.

1.3 PROJECT CONDITIONS

- A. Plant-Mixed Concrete: Schedule delivery of concrete to provide consistent mix times from batching until discharge.
- B. Concrete Paving: Schedule placement to minimize exposure to wind and hot sun before curing materials are applied. Avoid placing concrete if rain, snow or frost is forecast within 24 hours. Protect fresh concrete from moisture and freezing.
- C. Formed Concrete: Schedule work to minimize differences in curing conditions. When possible, apply the curing compound as soon as forms are stripped.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Concrete Color Additives: Provide products manufactured by Decorative Concrete Resources of Saginaw, 5093 N. Michigan, Saginaw, MI 48604; Tel: 866.792.9009 or 989.792.9000. Fax: 989.792.9518; Web Site: <https://www.dcrconcrete.com/>
- B. Substitutions: Not permitted.

2.2 COLORS

- A. Concrete Colors: Synergy Integral Colors Precast Concrete Color “WHEAT LIGHT”
- B. Concrete Colors: Provide cement, aggregate, and color additive as required to produce consistent colors using the materials specified.
- C. Concrete Paving:
 - 1. Cement: Gray.
 - 2. Color Additive: “WHEAT LIGHT”
 - 3. Sand: Manufactured white sand.
 - 4. Aggregate: provide sample for exposed Aggregate paving finishes

2.3 MATERIALS

- A. Colored Concrete Additive: Made with pure, concentrated mineral pigments especially processed for mixing into concrete and complying with ASTM C 979.
 - 1. Base dosage rates on weight of Portland cement, fly ash, silica fume, lime and other cementitious materials but not aggregate or sand.
 - 2. Color additives containing carbon black are not acceptable.
 - 3. Packaging: If color additives are to be added to mix at site, furnish color additives in premeasured Mix-Ready disintegrating bags to minimize job site waste.
- B. Admixtures: Do not use calcium chloride admixtures.
- C. Curing Compound for Colored Concrete: Comply with manufacturer's instructions and with ASTM C 309.
- D. Form Facing Material: Non-porous surface; steel, plastic, or high-density overlaid plywood, as permitted by applicable specification; with watertight joints, sealed to prevent leakage.
- E. Form Ties: Fiberglass rods tinted to match concrete.
- F. Supports for Reinforcing Bars: Use corrosion-resistant types at locations in contact with exposed surfaces.

2.4 MIXES

- A. Concrete Mix: Mix color additives in accordance with manufacturer's instructions, until color additives are uniformly dispersed through-out mixture and disintegrating bags, if used, have dis-integrated.

PART 3 EXECUTION

3.1 MOCK-UP COLOR AND FINISH SAMPLES

- A. Contractor to provide an 8 ft x 8 ft mockup representing the color and finishes per concrete pavement mockup schedule provided in the construction documents for approval.

- 1. "WHEAT LIGHT" – Medium Broom Finish
- 2. "WHEAT LIGHT" – Smooth Finish
- 3. Standard Concrete

3.2 FORMED SURFACES

- A. See applicable sections.
- B. Stripping: Leave forms in place as long as practical. Remove forms when concrete has reached a consistent age to maintain uniformity of curing conditions throughout Project.
 - 1. Minimize differences in curing conditions.
 - 2. When possible, apply the curing compound as soon as forms are stripped.

3.3 FLOORS AND PAVING

- A. See applicable sections for additional requirements.
- B. Broomed Finish: Do not dampen brooms. Soft Broom Finish.
- C. Trowel Finish: Do not over-trowel or start troweling late.

3.4 PATCHING CONCRETE

- A. Fill holes and defects in concrete surface within 48 hours of form removal.
- B. Use the same patching materials and techniques that were approved on mockup.
- C. Make patches with a stiff mortar made with materials from the same sources as the concrete. Adjust mortar mix proportions so dry patch matches dry adjacent concrete. Add white cement to mortar mix if necessary to lighten it.
- D. Exposed Aggregate Finish: Add aggregate to mortar mix so patches will have the same texture and appearance as adjacent concrete.

3.5 CURING CONCRETE

- A. Maintain concrete between 65 and 85 F (18 to 29 C) degrees during curing.
- B. Cure concrete using curing compound; apply curing compound in accordance with manufacturer's instructions.
 - 1. Precast Concrete: If use of curing compound is not practical, use curing techniques which have been shown to adequately cure concrete and which produce acceptable color and appearance.

3.6 TOLERANCES

- A. Minor variations in appearance of colored concrete, which are similar to natural variations in color and appearance of unpigmented concrete, are acceptable.

END OF SECTION

SECTION 26 56 33 (16492)
OUTDOOR CHARGING STATION

PART 1 GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and Division 1 – General Requirements apply.

1.2 SECTION INCLUDES

- A. Power pedestal

1.3 RELATED SECTIONS

- A. Division 16 - Electrical: Electrical systems and components.
- B. Section [xxxxx] – [Section Title]: [Include brief description of work specified in another section that is related to the work of this section.]

1.3 SUBMITTALS

- A. Product Data: Submit for [charging stations] [power pedestal] and components.
- C. Shop Drawings: For [charging stations] [power pedestal] and components. Include plans, elevations, sections, details, and attachments to other work. With WSU Shield Branding.
- D. Samples: Submit [one (1)] [insert quantity] sample for each type of [charging station] [power pedestal] component specified with required color and finish. Show standard color and finish ranges available. (L. Black)

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of charging stations, power pedestals, and components of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide charging stations, power pedestals, and components produced by a manufacturer listed in this section.
- B. Charging Stations, Power Pedestals, and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to charging stations, power pedestals, and components. UL listed to meet NEMA 3R requirements for use in outdoor locations. cULus listed per File No. E479489 in compliance with UL Standard 1773.
- C. Charging stations and power pedestals comply with ADA requirements

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver [charging stations] [power pedestals] and associated components in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- C. Protect from damage due to weather, excessive temperature, and construction operations.

1.6 WARRANTY

- A. Warranty Information: Legrand Wiremold warrants, to the original purchaser or owner only, that the Products are substantially free of defects in material and workmanship under normal use and service, for a period of one year from the date of original installation or two years from the date of purchase, whichever is sooner. This limited warranty applies only to Products that have been

installed properly in accordance with installation instructions supplied by Wiremold and any applicable codes and standards.

This limited warranty is void and Wiremold shall not be liable for any damages or held responsible for the quality, performance or safety of Products that have been repaired, altered or tampered with outside of Wiremold facilities or that have been intermixed (used within a system) with products or materials not approved by Wiremold, or that have been subjected to accident, negligence, misuse or abuse.

Wiremold's sole obligation (and the sole and exclusive remedy of the purchaser or owner of the Product) with respect to any Products that are shown to be defective shall be the repair or replacement of the defective Products, at the sole option of Wiremold. Returned Products will not be accepted unless Wiremold is notified and authorizes the return prior to shipment.

THE WARRANTIES LISTED ABOVE ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED OR STATUTORY; INCLUDING, BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE, ALL OF WHICH ARE HEREBY WAIVED BY DISTRIBUTOR AND DISCLAIMED BY WIREMOLD.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Landscape Forms, Inc., 7800 E. Michigan Ave, Kalamazoo, Michigan 49048.
Phone: (800) 521-2546. Fax (269) 381-3455. Website www.landscapeforms.com
E-mail: specify@landscapeforms.com

2.2 MATERIALS

- A. Top Cap and Pedestal Body: 0.188-inch thick aluminum extrusion
- B. Pedestal Base: Steel base with 4-1/4-inch [108mm] opening and four (4) 3/8-inch [9.5mm] diameter "L" bolts, eight inches [203mm] long, zinc-plated steel.
- C. Shelves: 0.25-inch thick aluminum coated with outdoor-rated PlastiKote coating.
- D. Optional Transparent Door: Polycarbonate; UL F1 rated to ensure UV resistance.
- E. Lenses: Polycarbonate; UL F1 rated to ensure UV resistance.
- F. Paint: Outdoor-rated powder coat.

2.3 OUTDOOR CHARGING STATIONS WITH ACCENT LIGHT

- A. Outdoor charging stations prewired with [two] [three] devices and a 7W, 4000k LED accent light for easy identification at night. Power and lighting are prewired on separate circuits. Lighting circuit can be controlled by a timer at the panel if desired. Can also be supplied unwired in two- and three-gang versions. Requires two inputs: 120v for receptacles and 120-277v line input for the accent light.
Supplied with color-matched door that can be easily replaced by a color-matched locking door or a transparent door.
Interior illuminates when door is open. Door closes automatically to meet while-in-use requirements.
- B. Two-Gang Outdoor Charging Station with Accent Light: LF Catalog No. BM-CSA-1G1U-[XXXX] with one (1) 20A weather-resistant GFCI and one (1) 4-port 4.2A USB outlet.
- C. Two-Gang Outdoor Charging Station with Accent Light: LF Catalog No. BM-CSA-2U-[XXXX] with two (2) 4-port 4.2A USB outlets.
- D. Two-Gang Outdoor Charging Station with Accent Light: LF Catalog No. BM-CSA-2G-[XXXX] with two (2) 20A weather-resistant GFCI outlets.
- E. Two-Gang Outdoor Charging Station with Accent Light: LF Catalog No. BM-CSA-2UW-[XXXX] unwired.

- F. Three-Gang Outdoor Charging Station with Accent Light: LF Catalog No. BM-CSA-1G2U-[XXXX] with one (1) 20A weather-resistant GFCI and two (2) 4-port 4.2A USB outlets.
- G. Three-Gang Outdoor Charging Station with Accent Light: LF Catalog No. BM-CSA-2G1U-[XXXX] with two (2) 20A weather-resistant GFCI outlets and one (1) 4-port 4.2A USB outlet.
- H. Three-Gang Outdoor Charging Station with Accent Light: LF Catalog No. BM-CSA-3UW-[XXXX] unwired.

2.4 OUTDOOR CHARGING STATIONS WITH AREA LIGHT

- A. Outdoor charging stations prewired with [two] [three] devices and a 25W, 4000k LED light for area illumination at night. Power and lighting are prewired on separate circuits. Lighting circuit can be controlled by a timer at the panel if desired. Can also be supplied unwired in two- and three-gang versions.
 - 1. Supplied with color-matched door that can be easily replaced by a color-matched locking door or a transparent door.
 - 2. Interior illuminates when door is open. Door closes automatically to meet while-in-use requirements.
- B. Two-Gang Outdoor Charging Station with Area Light: LF Catalog No. BM-CSL-1G1U-[XXXX] with one (1) 20A weather-resistant GFCI and one (1) 4-port 4.2A USB outlet.
- C. Two-Gang Outdoor Charging Station with Area Light: LF Catalog No. BM-CSL-2U-[XXXX] with two (2) 4-port 4.2A USB outlets.
- D. Two-Gang Outdoor Charging Station with Area Light: LF Catalog No. BM-CSL-2G-[XXXX] with two (2) 20A weather-resistant GFCI outlets.
- E. Two-Gang Outdoor Charging Station with Area Light: LF Catalog No. BM-CSL-2UW-[XXXX] unwired.
- F. Three-Gang Outdoor Charging Station with Area Light: LF Catalog No. BM-CSL-1G2U-[XXXX] with one (1) 20A weather-resistant GFCI and two (2) 4-port 4.2A USB outlets.
- G. Three-Gang Outdoor Charging Station with Area Light: LF Catalog No. BM-CSL-2G1U-[XXXX] with two (2) 20A weather-resistant GFCI outlets and one (1) 4-port 4.2A USB outlet.
- H. Three-Gang Outdoor Charging Station with Area Light: LF Catalog No. BM-CSL-3UW-[XXXX] unwired.

2.4 POWER PEDESTALS

- A. Outdoor power pedestals provided with [two] [three] devices. Can also be supplied unwired in two- and three-gang versions. Requires 120v line input.
 - 1. Supplied with color-matched door that can be easily replaced by a color-matched locking door or a transparent door.
 - 2. Interior illuminates when door is open. Door closes automatically to meet while-in-use requirements.
- B. Two-Gang Outdoor Power Pedestal: LF Catalog No. BM-PP-1G1U-[XXXX] with one (1) 20A weather-resistant GFCI and one (1) 4-port 4.2A USB outlet.
- C. Two-Gang Outdoor Power Pedestal: LF Catalog No. BM-PP-2U-[XXXX] with two (2) 4-port 4.2A USB outlets.
- D. Two-Gang Outdoor Power Pedestal: LF Catalog No. BM-PP-2G-[XXXX] with two (2) 20A weather-resistant GFCI outlets.
- E. Two-Gang Outdoor Power Pedestal: LF Catalog No. BM-PP-2UW-[XXXX] unwired.
- F. Three-Gang Outdoor Power Pedestal: LF Catalog No. BM-PP-1G2U-[XXXX] with one (1) 20A weather-resistant GFCI and two (2) 4-port 4.2A USB outlets.
- G. Three-Gang Outdoor Power Pedestal: LF Catalog No. BM-PP-2G1U-[XXXX] with two (2) 20A weather-resistant GFCI outlets and one (1) 4-port 4.2A USB outlet.
- H. Three-Gang Outdoor Power Pedestal: LF Catalog No. BM-PP-3UW-[XXXX] unwired.

2.5 OUTDOOR CHARGING STATION ACCESSORIES

- A. A/V-Communication Kit: enables combining power and low voltage in one (1) three-gang pedestal; includes two (2) device plates to accommodate either two (2) decorator-style power devices and one (1) decorator style A/V or communication device or two (2) decorator-style power devices and four (1) charging station manufacturer's AVIP device plates.
- B. Transparent Door: manufactured from polycarbonate; replaces color-matched door.
- C. Replacement Door: replacement door for all charging stations included with initial shipment of all models.
- D. Locking Door: replacement door for all charging stations included with initial shipment of all models.
- E. Device Shelves: pair of shelves hold a mobile device while charging; PlastiKote® finish. Shelves are designed to mount to pedestal sides and have been tested to hold up to 250 lbs. Use a maximum of two (2) shelves per pedestal. Shelves mount below door opening.
 - 1. Black

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which [charging stations] [power pedestals] and components are to be installed. Notify the [Architect/Engineer] [Construction Manager] in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Examine roughing-in for [charging stations] [power pedestals] and conduit to verify actual locations of installation.

3.2 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate [charging stations] [power pedestals] installation with adjacent work to ensure proper clearances and to prevent electrical hazards. Remove any burrs or sharp edges on material.
- B. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.
- C. Stub up conduit to a height of eight (8) inches for standard power installations. If using the A/V kit, run the conduit up to bottom of power module/door.

3.3 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Protect [charging stations] [power pedestals] and components from damage until acceptance. Replace [charging stations] [power pedestals] components which are damaged during construction.

END OF SECTION

SECTION 31 05 13
SOILS FOR EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Earth backfill and topsoil materials

1.02 REFERENCED SECTION

- A. Section 01 40 00 - Quality Requirements

1.03 REFERENCES

- A. ASTM International. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.
 - 1. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³(2,700 kN-m/m³))
 - 2. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 - 3. ASTM D2922 - Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 4. ASTM D2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

PART 2 PRODUCTS

2.01 SOIL MATERIALS

- A. Earth backfill: Excavated and re-used material or imported material, graded, free of lumps larger than 3 inches, rocks larger than 2 inches and debris. Material shall conform to ASTM D2487 Group Symbol CL or OL.
- B. Top Soil: Excavated and re-used material or imported material, graded, free of roots, rocks larger than one-half inch, subsoil, debris, large weeds and foreign matter. Material shall conform to ASTM D2487 Group Symbol OH or PT.

2.02 SOURCE QUALITY CONTROL

- A. Inspection will be performed under provisions of Section 01 40 00.

PART 3 EXECUTION

3.01 STOCKPILING

- A. Stockpile materials on site.
- B. Stockpile in sufficient quantities to meet project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Direct drainage runoff away from stockpile to prevent erosion or deterioration of materials.

3.02 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in a clean and neat condition. Grade site to prevent standing water.

END OF SECTION

SECTION 31 05 16
AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate materials to construct a granular subbase on an approved surface.

1.02 REFERENCES

- A. MDOT 2012 Standard Specifications for Construction – Section 902
- 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 D3017 - Test Methods for Moisture Content of Soil and Soil Aggregate Mixtures.

PART 2 PRODUCTS

2.01 AGGREGATE MATERIALS

- A. Class II – Class II granular material conforming to MDOT Specification 902.07 - Granular Materials for Fill and Subbase.
- B. MDOT 21AA, 21A, 22A, 23A - Dense graded aggregate for aggregate base course conforming to MDOT Section 902.05 -Dense Graded Aggregates, Surface Course, Shoulders, and Patching.
- C. Granular fill: Well graded cohesionless soil materials complying with AASHTO 145 soil classifications group A-1, A-2, or A-3.

2.02 SOURCE QUALITY CONTROL

- A. Tests and analysis of aggregate material will be performed in accordance with ANSI/ASTM D1557 and ASTM D3017.
- B. If tests indicate materials do not meet specified requirements, all stockpiled and placed material is to be removed of and disposed of off-site.

PART 3 EXECUTION

3.01 STOCKPILING

- A. Stockpile in sufficient quantities to meet project schedule and requirements.
- B. Separate differing materials with dividers or stockpile apart to prevent contamination of materials.
- C. Direct surface water away from stockpile site so as to prevent erosion or deterioration of materials.

3.02 STOCKPILE CLEANUP

- A. Remove remainder of stockpile areas, return area to a clean and neat condition. Grade site surface to prevent free standing surface water and restore with seed or as appropriate.
- B. If a borrow area is indicated, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 22 00
GRADING

PART 1 GENERAL

1.01 SUMMARY

- A. Provide all materials, labor, equipment, and services necessary to complete all site grading as indicated in this Construction Documents. The work consists of, but is not limited to:
 - 1. Stripping, stockpiling, and removal of Topsoil.
 - 2. Earth moving and land balance required to meet proposed subgrades.
 - 3. Subgrade preparation of building slabs, walks, and pavements.
 - 4. Compaction of all areas in native soil, cut, or fill.
 - 5. Stockpiling and removal of suitable and unsuitable material other than Topsoil.

1.02 QUALITY ASSURANCE

- A. If required, the services of a Soils Engineer and Soils Laboratory will be retained by the Owner, to observe earthwork operations, analyze soil materials and perform applicable laboratory and field tests.
- B. The Contractor shall arrange and pay for any other test or required inspections needed to meet the requirements set forth in these Construction Documents.
- C. As a minimum the Soils Engineer shall perform the following tests:
 - 1. The soils laboratory shall analyze all native or imported fill and backfill material and topsoil proposed for use to determine the suitability for use and compliance with the Contract Documents.
 - a. Fill and backfill material shall be examined as to soil classification and tested to determine the plasticity index, optimum moisture content and dry density.
 - b. After rough grading and prior to spreading of topsoil, the topsoil in lawn areas and the topsoil to be placed in and subgrade in planting beds shall be examined for organic content, acidity and soil composition.
 - 2. All-natural grades to be retained, all areas of cut, and all areas of controlled fill shall be field tested by the Soils Engineer for moisture content and percent of compaction for compliance with specified values.
 - a. The number of tests performed shall be at the discretion of the Soils Engineer. Except that the number of field tests performed shall not be less than the minimum described below.
 - 1) Within the building area perform one (1) test for every 500 cubic yards of fill and backfill or in areas of natural grade or cut one (1) test for every 10,000 square feet, except that such tests must be located as to give equal coverage to all portions of the building subgrade.
 - 2) Within the paved areas of the site, except trench excavations perform one (1) test for every 2000 cubic yards

of fill or in areas of natural grade or cut one (1) test for every 40,000 square feet.

- D. Emphasis should be given to the aesthetic appearance and functioning of berms and swales, as directed by the Landscape Architect or Owner's Representative. The Contractor shall employ skilled personnel and any necessary equipment to ensure that finish grading is smooth, aesthetically pleasing, drains well and is ideal for receiving sod and plant materials.

1.03 SUBMITTALS

- A. The Soils Engineer shall submit the following reports directly to the Owner or Owner's Representative, with a copy to Contractor:
 - 1. Classification and suitability of borrow material.
 - 2. Field reports; in-place soil density tests.
- B. Compaction Results
 - 1. The Soils Engineer shall advise the Contractor and Owner or Owner's Representative immediately of any compaction tests failing to meet specified minimum requirements. The contractor shall take appropriate steps to meet the compaction requirements. No additional lift is to be placed onto a soil with any portion failing to meet compaction requirements.

1.04 DEFINITIONS

- A. EXCAVATION: Consists of removal of material encountered to subgrade elevations indicated on the Plans, Specifications, Addenda, Change Orders or other written direction by the Owner.
- B. UNAUTHORIZED EXCAVATION: Consists of removal of materials beyond indicated elevations or dimensions. Unauthorized excavation will be restored as indicated below at no expense to the Owner.
 - 1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when approved by Soils Engineer.
 - 2. In locations other than those above, backfill and compact unauthorized excavations with material approved by the Soils Engineer.

1.05 JOB CONDITIONS

- A. The Contractor shall visit the site and acquaint himself with all existing conditions. The Contractor shall be responsible for his own subsurface investigations, as necessary, to satisfy requirements of this Section. All subsurface investigations shall be performed only under time schedules and arrangements approved in advance by the Owner's Representative.
- B. SITE INFORMATION: The data provided regarding subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that the Owner will not be responsible for interpretations or conclusions made by the Contractor. Subsurface data may be provided by the Owner.
- C. It will be the responsibility of the Contractor to coordinate and schedule the Site grading operations with the excavation and Site Utility Contractors so as to provide for a smooth and orderly progression of the Work.

- D. The Owner shall provide the services of a Registered Land Surveyor to establish all lines, levels, grades, bench marks and measurements required to lay out the Work.
- E. Construction stakes becoming misaligned are to be checked before proceeding with the Work. Any re-staking required will be performed by the owner's surveyor and back-charged to the contractor.
- F. EXISTING UTILITIES: Locate existing underground utilities in areas of Work. If utilities are to remain in place, provide means of support and protection during earthwork operations.
 - 1. Before starting site operations, verify that the earlier Contractors have disconnected all temporary utilities which might interfere with the fine grading work.
 - 2. Observe rules and regulations governing respective utilities in working under requirements of this section. Adequately protect utilities from damage, remove or relocate as indicated, specified or required. Remove, plug or cap inactive or abandoned utilities encountered in excavation. Record location of active utilities.
 - 3. Should pipes, conduit, or other utilities be encountered during excavation, consult Utility Owner immediately for directions. Cooperation with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of Utility Owner.
 - 4. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by the Owner and then only after acceptable temporary utility services have been provided.
 - a. Provide minimum of 48-hours' notice to the Owner and receive written notice to proceed before interrupting any utility.
 - 5. Demolish and completely remove from Site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.
- G. Protect bench marks, utilities, structures, fences, sidewalks, paving, curbs and other facilities from earthwork equipment. In the event of damage, immediately make all repairs, replacements and dressings to damaged plants necessary. Contractor shall incur all cost for the replacement of damaged objects and vegetation.
- H. Natural features which are not subject to changes by reason of the Drawings and Specifications shall not be defaced or injured in any manner.
- I. The Contractor shall guard against movement or settlement of adjacent buildings or structures, and provide bracing, as necessary. He shall be responsible for safety and support of such buildings or structures and be liable for any movement or settlement. If at any time any adjacent buildings or structures appear to be endangered or unsafe, he should cease operations, and take precautions to support such buildings or structures. Once building or structures have been stabilized, the Contractor should notify the local Building Inspector and the Engineer. Operations shall be resumed only after permission has been granted. If the Engineer or Building Inspector considers additional bracing or shoring necessary to safeguard, or prevent movement or settlement, such bracing or shoring should be installed. If the Contractor fails to comply promptly with such

order, such bracing and shoring may be placed by the Owner, at no expense to the Owner.

- J. Dust control: Use all means necessary to prevent dust from construction operations from being a nuisance to adjacent property owners and from damaging finish surfaces on adjacent building, paving, etc. Methods used for dust control are subject to approval by the Land-scape Architect of Owner's Representative.

PART 2 PRODUCTS

2.01 FILL MATERIAL

- A. Materials for fill required to achieve design grades shall be either on- or offsite soils which are free of organic matter and debris suitable for compaction to required densities.
- B. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

PART 3 EXECUTION

3.01 TOPSOIL STRIPPING / REMOVAL

- A. Excavate or strip topsoil in all cut-and-fill areas and stockpile for later use in connection with finish grading / landscape restoration. Excavate topsoil to the depths required to remove all organic material from subgrade, but not less than 2-in. Transport and deposit topsoil in stockpiles at designated locations in a manner convenient for spreading and finish grading.
- B. Any excavated or stripped topsoil for later use in connection with finish grading shall be screened of all debris prior to reuse.
- C. It shall be the responsibility of the contractor to dispose of any unused topsoil offsite in a legal manner.

3.02 STOCKPILING

- A. Contractor may be allowed to stockpile excavated topsoil, separate from other excavated materials for later use. Stockpile area shall be cleared and grubbed prior to placing any topsoil. Keep stockpile free of all undesirable materials. Make stockpiles neatly shaped, and free to drain. Place stockpiles at locations shown on Drawings or as directed by Owner.

3.03 PROOF ROLLING

- A. Do all cutting or site grading work required to meet indicated subgrades. After completion of the earthwork operation, the subgrade area not receiving fill material shall be proof rolled in place and then compacted as specified under "Compaction Density" for a particular area classification. The subgrade area receiving fill material shall be proof rolled prior to placement of fill.
 - 1. During the performance of site grading operations, the subgrade shall be examined critically; and any areas discovered which, in the opinion of the Owner's Representative or Soils Engineer, are soft and unstable, shall be excavated to such depths as may be necessary to insure satisfactory supporting properties. These areas of excavation shall be backfilled immediately and shall be brought back to the elevation of the surrounding areas with approved fill material and in accordance with the earth fill construction procedure.

2. If pockets of unstable ground are encountered, notify the Owner's Representative or Soils Engineer to determine course of action. Do not proceed in area until authorization is granted.

3.04 PLACEMENT

- A. Prior to grading operations, remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
- B. Fill all areas as required to meet indicated subgrades. Fill material shall conform to the requirements of these Specifications and shall be approved by the Soils Engineer prior to placement.
 1. The surface of all areas shall be scarified by means of a disc or harrow to a minimum depth of 4-6 inches. An initial three-inch (3") layer of fill material shall then be spread over the scarified surface and the entire area compacted per the "Compaction Density" requirements.
- C. Fill shall be deposited in 9-in. loose layers for material compacted by heavy compaction equipment, and not more than 4" layer when compacted by hand-operated tampers.
 1. No frozen material should be used as fill nor shall any fill be placed on surfaces that are frozen or contain frost or ice.
 2. When the fill meets the natural grade of a slope, a bench shall be cut in the existing slope. These cuts are to serve as keys to connect the existing grades with a newly-placed fill.
- D. The moisture content of fill material shall not deviate from the optimum by more than 2 percent. Moisture content shall not exceed the optimum of any material which displays pronounced deformation under construction equipment. Drying of wet soil shall be expedited by the use of plows, discs, harrows, or other approved methods. If additional water is required, it should be uniformly distributed through the use of approved water wagons and shall be thoroughly incorporated into the material by means of discs or other suitable mixing equipment. Care shall be taken to avoid trapping water within the fill.
- E. If sufficient approved native fill material is not available to achieve indicated subgrade elevations, the Contractor shall obtain additional material from off-site borrow pits.

3.05 FINISH GRADING

- A. Perform topsoil installation 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. Regardless of finish grading elevations indicated, it is intended that grading be such that proper drainage of surface water will be directed away from buildings and that no low areas are created to allow ponding. Contractor to consult with Owner or Landscape Architect regarding minor variations in grade elevations before rough grading is completed.
- C. Supply and spread topsoil to a uniform depth as noted on the plans or indicated in the landscape restoration section of the contract documents.
- D. Grade lawn areas to a smooth, free draining even surface with a loose, moderately coarse texture ready to accept seed or sod.

- 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. Engineer to verify final contouring before planting.
- G. The surface will be graded smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of $\pm 1/10$ of a foot when tested with a 10' straightedge.

3.06 LAND BALANCE

- A. A balanced grading plan is NOT provided for this project. All removal of material from the site or fill material necessary to bring the site to the indicated elevations shall be the Contractor's responsibility as part of the base bid. The Contractor is responsible to make his own determination of the quantity of required fill or surplus material.

3.07 UNNECESSARY GRADING

- A. Unnecessary Grading: The expense of grading of materials outside of limits indicated or ordered in writing by the Engineer and the correction thereof to the satisfaction of the Engineer shall be borne by the Contractor.
- B. Unnecessary grading under footings: Either deepen footings to bear on actual subgrade elevation without changing top elevations or place concrete fill up to required elevation, as required by the Engineer.
- C. Unnecessary grading other than under footings: Either place compacted fill or otherwise correct conditions, as required by the Engineer.
- D. When required by the architect due to the unforeseen presence of unsatisfactory materials or other factors, perform additional grading and replace with approved compacted fill material in accordance with the Owner's instructions.
- E. Payment for unforeseen additional work will be made in accordance with established unit prices or, if none, in accordance with provisions for changes in the work. No payment will be made for correction of subgrades improperly protected against damage from freeze-thaw or accumulation of water, or for correction of otherwise defective subgrades.

3.08 COMPACTION / DENSITY

- A. Compact to at least the following percentage of maximum density, as determined by ASTM D-1557 (Modified Proctor). No deviation from these compaction densities will be allowed unless specifically approved by the Soils Engineer:

<u>Material</u>	<u>% of Maximum Density</u>
Fill under building (extending 5 feet beyond footings at a slope of 1 on 1)	98%
Fill under pavement or sidewalks, and within a 1:1 slope	95%
Fill placed under or behind retaining walls	95%
All other fill	90%

- B. No backfill shall be placed against any masonry or other exposed building surface until permission has been given by the Owner's Representative, and in no case until the masonry has been in place seven days.
- C. Compaction in limited areas shall be obtained by the use of mechanical tampers or approved hand tampers. When hand tampers are used, the materials shall be deposited in layers not more than four inches thick. The hand tampers used shall be suitable for this purpose and shall have a face area of not more than 100 square inches. Special precautions shall be taken to prevent any wedging action against masonry or other exposed building surfaces.
- D. Place backfill and fill materials in layers not more than 9 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

3.09 MAINTENANCE

- A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.
- D. Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent Work. Eliminate evidence of restoration to greatest extent possible. No additional payment will be made.

3.10 FIELD QUALITY CONTROL

- A. Compaction testing will be performed in accordance with ASTM D1557.
- B. If tests show Work does not meet specified requirements, remove Work, replace and retest.
- C. Frequency of Tests: Every 50 feet apart or as specified by the Engineer.

3.11 CORRECTION OF GRADE

- A. Bring to required grade, areas where settlement, erosion, or other grade changes occur. Adjust grades as required to carry drainage away from buildings and to prevent ponding around the buildings and on pavements.
- B. Remove all rock or objectionable material larger than 1 inch prior to commencing landscaping.

- C. Contractor shall be responsible for
 - 1. Stabilizing grades by approved methods prior to landscaping
 - 2. Correction of grades as mentioned above, and
 - 3. Cleaning up any wash outs or erosion.

3.12 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Contractor is to completely remove from site all waste material, including unacceptable excavated material, trash and debris, in a legally established method.

END OF SECTION

SECTION 31 23 16 EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavating for building and tank foundations.
- B. Excavating for slabs-on-grade, paving and landscaping.
- C. Excavating for site structures.

1.02 REFERENCED SECTIONS

- A. Section 01 40 00- Quality Requirements
- B. Section 31 23 23.13 - Backfill.

1.03 FIELD MEASUREMENTS

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.

1.04 UNIT PRICES

- A. For bid purposes, it was assumed that ten inches of material would be excavated throughout the project.
- B. For construction, the Engineer will provide a centerline profile. Excavation will be calculated based on the compacted in place excavation quantities.
- C. The final design may reflect significantly less excavation than that indicated on the proposal.
- D. The bid quantity is for bidding purposes only. Contractor should refer to soils report for information pertaining to excavation. It was assumed that any topsoil stripped from the construction area can be screened and reused in accordance with the landscaping specifications and details for this project. The Contractor should fully understand that the bid quantity is only an estimation and all additional excavating/embankment required to construct the project in accordance with the plans is the responsibility of the contractor and will not be paid for separately.

PART 2 PRODUCTS

2.01 MATERIALS

Not Used

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag location of known utilities. Notify Miss Dig and utility companies 72 hours before starting excavating operations.
- C. Notify utility company to remove and relocate utilities.
- D. Protect plant life, lawns, and other features remaining as a portion of final landscaping.

- E. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

3.02 EXCAVATION

- A. Underpin adjacent structures which may be damaged by excavation work.
- B. Excavate subsoil required to accommodate pump station foundations, slabs-on-grade paving and site structures, and construction operations.
- C. Machine slope banks to angle of repose or less, until shored.
- D. Do not excavate within 1 vertical to 1 horizontal slope of foundation.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- F. Hand trim excavation. Remove loose matter.
- G. Remove lumped subsoil, boulders and rock up to 1/3 cu y measured by volume.
- H. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- I. Correct areas over-excavated in accordance with Section 31 23 23.13.
- J. Stockpile excavated material in area designated on site and remove excess material not being reused from site.
- K. Over-excavate and place layer of stone fill in wet areas, as directed by Engineer, to maintain stable platform for equipment and to maintain stable excavation bottom.

3.03 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Section 01 40 00.
- B. Provide for visual inspection of bearing surfaces.

3.04 PROTECTION

- A. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.
- B. Protect bottom of excavations, and soil adjacent to and beneath foundation, from freezing.
- C. Protect excavation from accumulating water. Provide and maintain dewatering system to remove water from excavated areas.

END OF SECTION

SECTION 31 23 16.13 TRENCHING

PART 1 GENERAL

1.01 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.

1.02 REFERENCED SECTIONS

- A. Section 01 31 00 Project Management and Coordination
- B. Section 01 14 00 Quality Requirements
- C. Section 31 05 13 Soils for Earthwork
- D. Section 31 05 16 Aggregates for Earthwork
- E. Section 03 30 00 Cast-In-Place Concrete

1.03 REFERENCES

- A. ASTM International. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.
 - 1. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - 2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
 - 3. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 - 4. ASTM D2922 - Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)

1.04 DEFINITIONS

- A. Utility: Any buried pipe, conduit or cable.

1.05 FIELD MEASUREMENTS

- A. Verify that survey bench mark and intended elevations for the Work are as shown on drawings.

1.06 COORDINATION

- A. Coordinate work under provisions of Section 01 31 00.
- B. Verify work associated with lower elevation utilities are complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Earth Backfill: As specified in Section 31 05 13.

- B. Class II Granular Material: As specified in Section 31 05 16.
- C. Concrete: Lean concrete conforming to Section 03 30 00 with a compressive strength of 2000 psi.

PART 3 EXECUTION

3.01 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.

3.02 EXCAVATION

- A. Excavate subsoil required for utilities.
- B. Excavation to 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 to conform to the schedule at the end of this Section.
- C. Do not interfere with 45 degrees bearing zone 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.

3.03 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: Place and compact materials in continuous layers not exceeding 12 inches compacted depth.
- D. Earth Backfill: Place and compact material in continuous layers not exceeding 8 inches compacted depth.
- E. See schedule at end of this Section for backfill requirements.
- F. Maintain optimum moisture content of fill materials to attain required compaction density.
- G. Leave fill material stockpile areas completely free of excess fill materials.

3.04 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.

3.05 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01 40 00.
- B. Compaction testing will be performed in accordance with ASTM D1557.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace, compact and retest.
- D. Frequency of Tests: Every 25 feet, as requested by Engineer, and under pavements.

3.06 PROTECTION OF FINISHED WORK

- A. Protect installed Work as acceptable to Engineer.
- B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.07 SCHEDULES

- A. Trench widths for hollow conduits:

<u>Pipe Diameter</u>	<u>Maximum Trench Width</u>
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 - Mechanically tamped sand or gravel (suitable excavated sand or gravel material may be used), placed in 6-inch lifts, loose measure. Compact to minimum 90% of maximum unit weight to a point 18 inches below finished grade. Top 18 inches, minimum of 95% of maximum unit weight.
 - b. Parallel trench less than 4 feet from a paved area, meet same requirements as a crossing trench.
 - c. Parallel trench less than 10 feet and greater than 4 feet from a paved area - Place backfill material into trench in 6-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
 - a. Crossing Gravel Pavement: Place backfill material 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. Immediately restore the roads, driveways and parking areas with MDOT 21A gravel or slag aggregate, at least 8 inches thick and maintain them in good, dust-free condition during the life of the contract. Add additional aggregate if settlement occurs. Before final acceptance of the road, driveway or parking area, top-dress with approved

material to match the original surface treatment. Suitably stabilize gravel with calcium chloride. Oil gravel, if necessary, to match original surface treatment.

- b. Parallel Trench less than 4 feet away: Meet same requirements as a crossing trench.

3. Open Fields and Lawn Areas

- a. Backfill trenches in lawn areas with excavated material placed into the trench in 12-inch lifts, with each lift thoroughly compacted.
- b. Backfill all other trenches by spreading backfill material neatly into trench. Regrade as necessary during the life of the contract.

4. Special Backfill

- a. Where called for on the plans or where required by "Road Permits", 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.
- b. 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 will work together to establish guidelines which, under reasonable circumstances, will 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. Compact to 95 percent modified proctor.

END OF SECTION

SECTION 31 23 23.13
BACKFILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Site filling and backfilling
- B. Fill under slabs on grade
- C. Fill under paving and parking lot
- D. Consolidation and compaction as scheduled
- E. Fill for over-excavation

1.02 REFERENCED SECTIONS

- A. Section 01 31 00 Project Management and Coordination
- B. Section 01 14 00 Quality Requirements
- C. Section 01 50 00 Temporary Facilities and Controls
- D. Section 31 05 13 Soils for Earthwork
- E. Section 31 05 16 Aggregates for Earthwork
- F. Section 03 30 00 Cast-In-Place Concrete

1.03 RELATED INFORMATION

- A. Document: Geotechnical reports; bore hole locations and findings of subsurface materials.

1.04 REFERENCES

- A. ASTM International. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.
 - 1. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³(2,700 kN-m/m³))
 - 3. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 - 4. ASTM D2922 - Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow depth).

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Earth Backfill: As specified in Section 31 05 13.
- B. Structural Fill: Class II material as specified in Section 31 05 16.
- C. Concrete: Lean concrete, structural concrete conforming to Section 03 30 00 with a compressive strength of 2,000 psi.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Where backfill will place un-equalized horizontal loading on concrete structure, verify that concrete has attained 70 percent of its design strength.

3.02 PREPARATION

- A. Compact subgrade to density requirements for subsequent backfill materials.
- B. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with fill as specified in Schedule at end of this section.

3.03 BACKFILLING

- A. Backfill areas 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. Structural Fill: Place and compact materials in continuous layers not exceeding 8 inches compacted depth.
- D. Earth Backfill: Place and compact material in continuous layers not exceeding 8 inches compacted depth.
- E. Employ a placement method that does not disturb or damage other work.
- F. Maintain optimum moisture content of backfill materials to attain required compaction density. Backfill against supported foundation walls and slabs. Do not backfill against unsupported foundation walls.
- G. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
- H. Slope grade away from building minimum 2 inches in 10 feet unless noted otherwise.
- I. Make gradual grade changes. Blend slope into level areas.
- J. Leave fill material stockpile areas free of excess fill materials.
- K. Remove surplus backfill materials from site.

3.04 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.

3.05 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01 40 00.
- B. Compaction testing will be performed in accordance with ASTM D1557.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- D. Frequency of Tests: Every 50 feet
- E. Proof roll compacted fill surfaces under slabs-on-grade and paving, as required by Engineer.

3.06 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01 50 00.
- B. Reshape and re-compact fills subjected to vehicular traffic.

3.07 SCHEDULE

- A. Fill under grass areas.
 - 1. Earth backfill to 3 inches below finished grade, compacted to 85% modified proctor.
- B. Fill under asphalt paving.
 - 1. Earth backfill to bottom of aggregate base course placed in 8-inch lifts and compacted to 95% modified proctor.
- C. Fill to correct over excavation. Lean concrete with minimum compressive strength of 2,000 psi.

END OF SECTION

SECTION 32 05 05
SELECTIVE DEMOLITION FOR EXTERIOR IMPROVEMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal and disposal or salvage of structures.
- B. Disconnection, capping, and removal of existing utilities.
- C. Demolition and removal of slabs on grade.
- D. Refer to items as indicated on drawings.

1.02 REFERENCED SECTIONS

- A. Section 01 60 00 Product Requirements
- B. Section 01 70 00 Execution and Closeout Requirements

1.03 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01 70 00.
- B. Accurately record actual locations of capped utilities and subsurface obstructions.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for demolition of structures, safety of adjacent structures, dust control, and disposal of materials.
- B. Obtain required permits from authorities.
- C. Notify affected utility companies prior to starting work and comply with their requirements.
- D. Conform to applicable regulatory procedures when discovering hazardous or contaminated materials.
- E. Rules, regulations or laws of any controlling Governmental Agency shall govern when they are more stringent than the requirements of this Section.

1.05 DESCRIPTION

- A. Provide all labor, materials, and equipment necessary for the completion of all Demolition as shown on the Drawings and specified herein.
- B. All on and offsite Work included consists of but is not limited to:
 - 1. Demolition in part or in whole of existing buildings, footings, foundations, structures, and facilities together with subsequent removal of resulting debris.
 - 2. Removal of existing sidewalks, drives, curbs, and pavement.
- C. Removal, disconnecting or capping off of existing utilities, underground structures, septic tanks, disposal fields, etc.
- D. Removal or clearing of landscaping, trees, brush, debris, and miscellaneous Site elements as indicated on the Drawings.
- E. Removal from Site and disposal of all excess and unusable material.

1.06 DEFINITIONS

- A. Remove: Remove items from existing construction and legally dispose of them off-site.
- B. Remove and Reinstall: Carefully remove items from existing construction, prepare them for reuse, and reinstall them where indicated. Prior to reinstalling the item, the Contractor shall make a determination as to its soundness. Items which exhibit signs of wear or deterioration shall only be discarded on agreement with the Owners Representative.
- C. Remove and Salvage: Remove items from existing construction and deliver them to owner.

1.07 QUALITY ASSURANCE

- A. The Contractor shall visit the Site so that a full understanding of the difficulties and restrictions for execution of the Contract are made. Verify the location of all pertinent items. No additional compensation will be allowed for failure to be so informed.
- B. The Contractor shall submit a schedule indicating proposed sequence of operations for selective demolition Work to the Owner for review prior to commencing Work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.
- C. Comply with regulatory requirements and notification regulations before beginning selective demolition.
- D. Comply with hauling and disposal regulations of authorities having jurisdiction. A receipt indicating acceptance of hazardous wastes from a landfill facility licensed to accept such materials shall be submitted to the owner.

1.08 JOB CONDITIONS

- A. Existing structures, utilities, drives, walks, etc., have been shown on the plans in their approximate location, others may exist and may be found upon visiting the site. It shall be the responsibility of the Contractor to accurately locate all facilities and to determine their extent. If such facilities obstruct the progress of the Work and are not indicated to be removed or relocated, they shall be removed or relocated only as directed by the Owner.
- B. Owner assumes no responsibility for the actual condition of items or structures to be demolished.
- C. Contractor shall investigate the possibility of existing septic tanks and drain fields near the location of existing foundations, prior to demolition. In the event that any possible septic tanks exist, this Contractor shall make further investigations, as necessary, to locate the septic tank and drain fields. Any septic tank and drain field found to exist shall be removed in accordance with the requirements of State and Local Health Departments.
- D. Protect trees, plants, and natural features which are to remain as final landscaping.
- E. Restore to their present conditions any pavement in public right-of-way that is disturbed by the Work under this Section. All pavement restoration work in public rights-of-way shall be performed to the satisfaction of the governmental agencies having jurisdiction.

- F. If cutting torches are used, take all necessary precautions to prevent setting of fires, including the use of fireproof tarpaulins and fire extinguishing apparatus adjacent to cutting area.
- G. Notify utility companies if removal or relocation of any existing utilities is required.
- H. Promptly repair damages caused to adjacent facilities by demolition Work.
- I. Do not close, block, or otherwise obstruct access to existing streets, sidewalks, driveways, and other adjacent occupied or used facilities during demolition. Any proposed closures shall have written permission from the authority having jurisdiction.
- J. Maintain existing utilities and protect them against damage during demolition operations.
 - 1. Do not interrupt utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.
 - 2. Maintain fire protection services during demolition operations.
- K. Environmental Controls: Use water sprinkling, temporary enclosures, and other methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection.
- L. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
- M. Underground Storage Tank Removal: Contact all State, Federal and local agencies as may be required and determine the governing agencies requirements and provide agency contact information to the owner prior to construction.
 - 1. Completely remove all tanks, equipment lines, foundations and surrounding soils. Keep owner informed as to the progress of the work and notify immediately of any irregularities.

1.09 DRAINAGE MAINTENANCE

- A. During the entire course of operations, all existing drainage ways, both into and from the Project area shall be maintained in a functional condition.
- B. At all times during the clearing operation, the exposed areas of subgrade shall be maintained in a condition compatible with positive drainage of the Work area. Failure to maintain such drainage shall be considered adequate cause for the Contractor to order temporary suspension of the Work.
- C. Cut drainage swales and provide temporary grading to carry storm water away from the demolition area. No water will be permitted to stand in open excavations.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Use repair materials identical to existing materials. If identical materials are unavailable, use new materials whose performance is equal to or surpasses that of the existing material.
- B. Comply with material and installation requirements specified in the individual sections of this contract.

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide, maintain, and later remove, temporary barriers, warning signs, blinker lights and other safety measures as required for the protection of personnel and the public.
- B. Locate, identify, and protect all known utilities which are to remain. If utilities are uncovered that are not shown on the plans, notify the owner and cease work in the immediate areas until instructed to how to proceed.
- C. Notify utility companies, if required to remove and/or relocate utilities.
- D. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structures to be demolished and adjacent facilities to remain.
- E. Cease operations and notify Owner immediately if safety of structure or adjacent structures appear to be endangered. Take precautions to support structure and DO NOT resume operations until a determination is made for continuing operations.
- F. Provide bypass connections as necessary to maintain continuity of service to occupied areas of building.
- G. Check with the water and sewer departments, Gas Company, and private utility companies to assure that all utilities and services, are inoperative prior to their removal.
- H. Protect trees, plant growth, and features designed to remain as final landscaping.
- I. If cutting torches are used, take all necessary precautions to prevent setting of fires, including the use of fireproof tarpaulins and maintenance of fire extinguishing apparatus adjacent to cutting area.

3.02 DEMOLITION REQUIREMENTS

- A. Conduct demolition to minimize interference with adjacent structures and occupancies.
- B. Cease operations immediately if adjacent structures appear to be in danger. Notify Engineer. Do not resume operations until directed.
- C. Conduct operations with minimum interference to public or private accesses. Maintain egress and access at all times.
- D. Conduct operations in such a manner as to create a minimum of noise, dust and other disturbances.
- E. Do not allow removed materials, rubbish and debris to accumulate. Keep construction area and all public and private property used in connection with the work in a neat and orderly condition.
- F. Do not interrupt existing utilities.
- G. Methods shall be such as to prevent premature collapse of any section and damage to facilities indicated to remain in place and new construction.
- H. Removed material not indicated for turning over to owner or specified for reuse, as well as rubble and debris resulting from removal operations, shall become the property of the contractor and shall be removed daily from the project site and legally disposed of off the project site.

- I. When required to lift materials and/or equipment over or near an existing occupied building, advanced notice and arrangements with the owner's representative must be made to have any potential endangered spaces vacated. No such lifting shall be done without the permission of the owner's representative.

3.03 DEMOLITION

- A. Perform demolition Work in a systematic manner. Use such methods as required to complete Work indicated on Drawings in accordance with demolition schedule and governing regulations.
- B. Sawcut asphalt pavement full depth at limits indicated for removal.
- C. Concrete pavement shall be sawcut full depth and removed to the joint nearest the indicated removal limit or where specifically directed.
- D. Where piping is to be bullheaded, provide a permanent, water-tight plug consisting of brick and concrete mortar, one foot thick or prefabricated plugs intended for this purpose.
- E. Maintain in operating conditions all active utilities, sewers and drains encountered.
- F. The Contractor shall use extreme caution in removing any structures and utilities above and below grade to prevent damage to existing utilities which are to remain in service. Any existing utilities to remain, which are in any way damaged, shall be replaced at no additional cost to the Owner.
- G. Conduct operations in such a manner as to minimize noise, dust and other disturbances.

3.04 DISPOSAL OF DEMOLISHED MATERIALS

- A. Demolished material not indicated for turning over to the owner or specified for reuse, including rubble and other debris, shall become the property of the contractor and shall be removed daily from the project site and legally disposed of off the project site, at no expense to the Owner.
 - 1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
 - 2. Burning of materials shall not be permitted on Site.

3.05 CLEANUP AND REPAIR

- A. Upon completion of demolition Work, remove tools, equipment, and demolished materials from Site.
- B. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start of operations. Repair adjacent construction damaged by demolition Work.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.01 DESCRIPTION:

- A. Plant mixed hot mix asphalt (HMA) consists of asphalt binder, aggregates, mineral filler and other additives. Refer to construction documents for additional requirements for producing, furnishing, and installing HMA.
- B. All provisions of section 501 of the 2003 Michigan Department of Transportation (MDOT) Standard Specifications of Construction shall apply except as stated herein.

1.02 SECTION INCLUDES

- A. HMA paving
- B. HMA patching
- C. HMA paving overlays
- D. Cold Milling of existing HMA pavement
- E. Pulverizing / Base Crushing of HMA pavement

1.03 REFERENCES

- A. MDOT 2003 Standard Specifications for Construction (MDOT)
- B. American Society of Testing Materials (ASTM)

1.04 QUALITY ASSURANCE

- A. Quality control for HMA pavements shall be in accordance with Section 503 of the 2003 MDOT Standard Specifications for Construction.
- B. Submit proposed mix designs for each HMA mix prior to commencement of work. Follow the Procedures Manual for Mix Design Processing for all mix designs. Provide written certification that the materials used in the mixture are from the same source as those used in developing the mix design and that each material item meets specified requirements.
- C. Testing, as required, will be performed by the owner/construction engineer in accordance with Section 504 of the 2003 MDOT Standard Specifications for Construction.
- D. HMA materials not complying with specified requirements shall be repaired or removed and replaced with new paving.

1.05 WEATHER LIMITATIONS

- A. Section 502 of the MDOT 2003 Standard Specifications for Construction shall govern.
- B. Do not place HMA or apply bond coat when precipitation is imminent or when moisture on the existing surface will prevent satisfactory curing.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Coarse aggregate shall consist of crushed stone, crushed gravel, a mixture of uncrushed gravel with either crushed stone or crushed gravel, or other inert

material having similar characteristics. It shall be composed of clean, tough, durable fragments free from an excess of flat or elongated pieces and shall be free of organic matter and deleterious substances and meet the requirements of Division 9 in the MDOT 2003 Standard Specifications for Construction.

- B. Fine aggregate shall be well graded from coarse to fine and consist of natural sand, stone screenings, or a blend of natural sand and stone screenings. It shall be composed of rough surfaced and angular grains of quartz or other hard durable rock and meet the requirements of Division 9 in the MDOT 2003 Standard Specifications for Construction.
- C. HMA surface course shall be a mixture of 4.5 percent to 7.0 percent viscosity graded Asphalt Cement AC-10 (85/100 penetration grade) meeting the requirements of Division 5 in the MDOT 2003 Standard Specifications for Construction for aggregate gradation and HMA. Refer to plans for pavement cross-sections and mix designs. Recycled asphalt products (RAP) are not allowed in surface course mixes.
- D. HMA leveling course shall be a mixture of 3 percent to 6 percent viscosity graded Asphalt Cement AC-10 (85/100 penetration grade) meeting the requirements of Division 5 in the MDOT 2003 Standard Specifications for Construction for aggregate gradation and HMA. Refer to plans for pavement cross-sections and mix designs.
- E. Bond Coat material shall be SS-1h or CSS-1h emulsified asphalt, Grade RS-2 and shall conform with the requirements specified in Section 904 of the 2003 MDOT Standard Specifications for Construction.

PART 3 EXECUTION

3.01 BASE PREPARATION

- A. Subgrade preparations shall consist of the final machining of the subgrade immediately prior to placing the bituminous base course. The surface shall be true to line and grade. Proof-roll all areas to receive the base course to locate all soft surface areas. Replace soil that deflects and will not compact with acceptable fill material and compact such fill in accordance with these Specifications.
- B. Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

3.02 HMA PLACEMENT

- A. HMA pavement construction methods shall conform to 502.03.F of the MDOT 2003 Standard Specifications for Construction.

3.03 LINE AND GRADE

- A. The contractor shall be responsible to provide construction layout to establish the line and grade from the construction plans.

3.04 BOND COAT APPLICATION

- A. The bond coat shall be applied with a pressure distributor and applied uniformly to horizontal and vertical surfaces abutting new HMA pavement at a rate of 0.10-gallons per square yard.
- B. The bond coat shall be applied sufficiently in advance of the laying of the wearing surface to permit drying but shall not be applied so far in advance or over such

an area as to lose its adhesiveness as a result of being covered with dust or other foreign material. Suitable precautions shall be taken by the Contractor to protect the surface while the bond coat is drying and until the wearing surface is applied.

3.05 GENERAL TRANSPORTING, SPREADING AND FINISHING

- A. Section 502 of the MDOT 2003 Standard Specifications for Construction shall govern.

3.06 EQUIPMENT

- A. Section 502 of the MDOT 2003 Standard Specifications for Construction shall govern.

3.07 PLACING AND COMPACTION

- A. Section 502 of the MDOT 2003 Standard Specifications for Construction shall govern.
- B. Protect newly placed HMA after final rolling. Do not permit vehicular traffic on the asphalt pavement until it has properly cured, and in no case sooner than six hours after compaction.

3.08 MINIMUM QUALITY REQUIREMENTS

- A. Test the in-place HMA base, leveling, and surface courses for compliance with the requirements for density, thickness and surface smoothness. Take not less than 3 inches diameter pavement specimens of each completed course, as specified under Field Quality Control for in-place Work, from locations as directed by the testing Engineer. Repair holes from test specimens as specified for patching defective Work.
- B. Core pavement to determine in-place compacted thickness and compare to cross-sectional pavement detail on the plans. Any thickness less than plan is not acceptable and will require replacement of the asphalt with no additional payment. Test in-place density according to ASTM D-2950.
- C. Each HMA course shall be tested for smoothness, using a 10-foot straightedge applied parallel with and at right angles to centerline of paved area according to MTM 722. Surfaces shall not be acceptable if exceeding the tolerances set forth in Section 502 of the MDOT 2003 Standard Specifications for Construction.

3.09 EXISTING DRAINAGE

- A. Do not block road drainage. Maintain shoulders, gutters and ditches affected by construction operations to carry drainage flows.

3.10 TEMPORARY REPAIRS

- A. Where it is not feasible to replace pavements immediately after completion of the excavation and backfill, furnish and place crushed stone or gravel as required to maintain traffic until the pavement can be restored. Continuously maintain the temporary crushed stone or gravel surfaces in a smooth condition, free of potholes or ruts, until the permanent pavement is restored.
- B. Restore permanent pavement within 30 days after the existing pavement has been cut.

3.11 COLD MILLING

- A. Clean existing pavement surface of deleterious material immediately before cold milling.

- B. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
- C. Mill to a uniform finished surface free of gouges, grooves, and ridges.
- D. Control rate of milling to prevent tearing of existing asphalt course.
- E. Repair or replace curbs, manholes, and other construction damaged during cold milling.
- F. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
- G. Transport milled hot-mix asphalt to asphalt recycling facility.

3.12 PULVERIZING / BASE CRUSHING

- A. Work shall be performed in accordance with Section 305 of the MDOT 2003 Standard Specifications for Construction.
- B. Pulverized material shall be graded and shaped to match the grades shown on the plans, or to provide positive drainage towards a storm water collection area where grades are not provided.

3.13 HMA PATCHING / REPAIRS

- A. Vertically sawcut full depth and along straight lines around deteriorated pavement and into adjacent sound pavement.
- B. Remove deteriorated pavement without damaging sawcut edges and dispose of legally offsite. Damaged edges shall be re-sawcut.
- C. Repair or replace curbs, structures, and other construction damaged during pavement excavation.
- D. Use 21AA material as specified in Section 32 11 00 and recompact to bring aggregate base course to bottom of existing pavement section.
- E. Use appropriate mechanical or hand placement equipment to install HMA in lifts not to exceed 2" compacted in place.
- F. Patching / repair HMA material shall consist of appropriate base, leveling, and wearing course mixes, to be approved by the owner prior to installation.
- G. Install necessary leveling wedges in compacted lifts not exceeding 2 inches thick.
- H. Use hot-applied joint sealant to seal joints around pavement repair.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Concrete Pavement
- B. Concrete Sidewalk, Ramps, and Steps
- C. Concrete Driveways / Drive Approaches
- D. Concrete Dumpster Pads

1.02 REFERENCES

- A. American Concrete Institute (ACI)
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 302 - Guide for Concrete Floor and Slab Construction.
 - 3. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - 4. ACI 305R - Hot Weather Concreting.
 - 5. ACI 306R - Cold Weather Concreting.
 - 6. ACI 308 - Standard Specification for Curing Concrete.
 - 7. ACI 318 - Building Code Requirements for Structural Concrete (ACI 318-05) and Commentary.
- B. ASTM International. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.
 - 1. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
 - 2. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - 3. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars
 - 4. ASTM B221 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
 - 5. ASTM C33 - Concrete Aggregates.
 - 6. ASTM C94 - Ready-Mixed Concrete.
 - 7. ASTM C150 - Portland Cement.
 - 8. ASTM C260 - Air Entraining Admixtures for Concrete.
 - 9. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 10. ASTM C494 - Chemicals Admixtures for Concrete.
 - 11. ASTM D994 - Preformed Expansion Joint Filler for Concrete (Bituminous Type).

- 12. ASTM D1190 - Concrete Joint Sealer, Hot-Poured Elastic Type.
 - 13. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
 - C. Concrete Reinforcing Steel Institute (CRSI)
 - 1. Manual of Standard Practice
 - D. Michigan Department of Transportation - MDOT
 - 1. 2020 Standard Specifications for Construction.
 - E. Americans with Disabilities Act (ADA)
- 1.03 DESCRIPTION
- A. Provide all materials, labor, equipment, and services necessary to complete the concrete improvements as indicated in the Construction Documents.
- 1.04 QUALITY ASSURANCE
- A. Installer shall be qualified with at least 3 years in business and has completed pavement work similar in material, design, and extent to that indicated for this Project.
 - B. Manufacturer shall be certified in the production of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
 - C. Submit concrete mix designs for proposed slabs on grade.
 - D. Submit shop drawings and certified copies of mill report of reinforcement materials analysis.
 - E. Concrete quality assurance testing, as required, will be performed by the owner/construction engineer in accordance with Sections 604 and 605 of the 2020 MDOT Standard Specifications for Construction.
 - F. Submit, to the Owner, two copies of materials certificates signed by Material Producer and Contractor. Certificates shall state that each material item meets specified requirements.
 - G. Submit, to the Owner, job-mix formulas for each required cement-aggregate mixture. Mix designs shall be within allowable tolerances as specified for the particular application.
- 1.05 TRAFFIC CONTROL
- A. Maintain vehicle and pedestrian traffic during paving and repair operations in such a manner as to not disrupt normal traffic activities unless special notification has been distributed.
- 1.06 WEATHER LIMITATIONS
- A. Construct pavement surface course only when ground temperature is above 40 degrees F. and base is dry. Base course may be laid when temperature is above 40 degrees F. and rising. Do not place pavement when base or surface is wet or frozen.
 - B. Cold Weather Protection
 - 1. When the temperature of the atmosphere is 40-degrees F and below, the concrete shall be protected by heating, insulation covering, housing or

combination thereof as required to maintain the temperature of the concrete at or above 50-degrees F and in a moist condition continuously for the concrete curing period.

2. Cold weather protection shall meet the requirements of ACI 306R "Cold Weather Concreting."

C. Hot Weather Protection

1. When the temperature of the atmosphere is 90-degrees F and above, or during other climatic conditions which will cause too rapid drying of the concrete, the concrete shall be protected by windbreaks, shading, fog spraying light-colored moisture-retaining covering, or a combination thereof as required to maintain the temperature of the concrete below 80-degrees F and in a moist condition continuously for the concrete curing period.
2. Hot weather protection shall meet the requirements of ACI 305R "Hot Weather Concreting."

1.07 SUBMITTALS

A. Concrete Mix Designs

1. Prior to any concrete pavement placement, the contractor shall submit a design mix for approval by the engineer for each pavement mix proposed. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
2. Proportion mixes to provide concrete for pavement and gutter and spillways with the following properties.
 - a. Compressive Strength (28 days): 4,000 psi, unless otherwise indicated
 - b. Maximum Aggregate Size: 1.5 inches
 - c. Slump: 3 inches (for formed concrete), 1.5 inches (for slipform placement)
 - d. Total Air Content by Volume: 5% to 8%

PART 2 PRODUCTS

2.01 MATERIALS

- A. All materials used in concrete pavement and spillway construction shall be in accordance with Section 801.02 of the MDOT 2020 Standard Specifications for Construction.
- B. The fine aggregate shall meet all requirements of the MDOT 2020 Standard Specification for No. 2NS Natural Sand.
- C. The coarse aggregate shall meet of requirements of the MDOT 2020 Standard Specification for No. 6AA Coarse Aggregate.
- D. Water used in concrete shall be clean, free from oil, acids strong alkalies or vegetable matter and potable. If City water is used in the concrete, all necessary permits shall be obtained from the City Water Department.
- E. Joint and waterproofing materials for use in concrete pavement shall conform to Section 904 of the MDOT 2020 Standard Specifications for Construction

- F. The curing compound shall be white membrane type and conform with ASTM C-309, Type 2.

2.02 READY-MIXED CONCRETE MANUFACTURER'S QUALIFICATIONS

- A. All ready-mixed concrete suppliers must be approved by the Owner. Concrete shall be manufactured and delivered to the job Site by a ready-mixed concrete manufacturer meeting the requirements of the National Ready Mixed Concrete Association (NRMCA) certification program.
- B. Ready-mixed concrete shall be mixed and delivered to the point of discharge at the job by means of a ready-mix concrete truck. Delivery tickets in accordance with Section 16 of ASTM C94 for each concrete load delivered to and used at the site shall be signed by the owner's designated representative. The delivery tickets shall provide at minimum the following information:
 - 1. Date
 - 2. Name of ready mix concrete plant
 - 3. Contractor
 - 4. Job location
 - 5. Type (Standard or H.E.S.) and brand of cement
 - 6. Cement content in bags per cubic yards of concrete
 - 7. Truck number
 - 8. Time dispatched and time unloaded
 - 9. Amount of concrete in load in cubic yards
 - 10. Admixtures in concrete
 - 11. Maximum allowable slump in inches
 - 12. Amount of water added at job in gallons, if any
- C. No water from the truck water system or elsewhere shall be added after the initial introduction of the mixing water for the batch. Under no circumstances shall the approved maximum water content be exceeded, nor shall the slump exceed the maximum specified.
- D. Discharge of the concrete shall be completed in compliance with Table 601-1 of the MDOT 2020 Standard Specifications for Construction.
- E. Concrete delivered in cold weather (air temperature 45-degrees F. and lower) shall have a temperature not less than 60-degrees F. at the point of discharge at job, and in compliance with ACI 306 R "Cold Weather Concreting". Concrete placing will not be permitted when the air temperature is 35-degrees F. or lower.
- F. Concrete delivered under hot weather conditions contributing to quick stiffening of concrete, or in air temperature of 80-degrees F. and over, shall have a temperature between 60- and 80-degrees F. at the point of discharge at job, and in accordance with ACI 305 R "Hot Weather Concreting."

2.03 REINFORCEMENT MATERIALS

- A. Reinforcing Bars: ASTM A615-84A, Grade 60 Deformed Billet-Steel Bars.
- B. Epoxy-Coated Reinforcement Bars: ASTM A775 with ASTM A615, Grade 60, deformed bars.
- C. Plain Steel Welded Wire Fabric: ASTM A185 plain type, flat sheet fabrication.

- D. Reinforcing Steel Bar and Rod Mats: ASTM A704, ASTM A615, Grade 60, deformed bars
- E. Epoxy-Coated Joint Dowel Bars: ASTM A615 with ASTM A615, Grade 60, plain steel bars.
- F. Hook Bolts per ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- G. Tie Wires to be black, annealed steel wire, not less than 16-gauge.
- H. Supports for Reinforcements: Bar supports conforming to "Bar Support Specifications" contained in ACI "Manual of Standard Practice". Provide chairs, spacers and other devices suitable for proper spacing, supporting and fastening reinforcing bars.
- I. Shop fabricate reinforcing bars to conform to the shapes and dimensions shown on the reviewed Shop Drawings and in accordance with ACI "Manual of Standard Practice," current edition.

2.04 FORMS

- A. All forms shall extend 1" deeper than full depth of the proposed pavement section and cleaned before each use.
- B. Fixed forms shall be of sufficient strength to resist springing during concrete-placing operations, and of an approved section with flat surface on top.
- C. Flexible form materials may consist of plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
- D. A commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces shall be applied to the forms before concrete installation.

PART 3 EXECUTION

3.01 GRADING

- A. All new pavement shall be placed on a prepared subgrade, smoothed and leveled to the grades indicated on the Plans.
- B. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction and repair as required. In clay soils the subgrade shall be excavated 4 inches below the sidewalk base and filled with approved sand meeting MDOT Class II granular fill.
- C. Grade all sidewalk ramps to achieve current ADA and barrier free requirements.

3.02 SETTING FORMS

- A. Compact and cut-to-grade subgrade under forms so that forms when set will be uniformly supported for the entire length. Securely stake and brace or tie forms to prevent leakage of concrete. Bracing with piles of earth will not be permitted.
- B. Coat surfaces of forms to be in contact with concrete with a light clear paraffin oil or parting compound which will not stain the concrete.
- C. Before start of concrete placing, form Work shall be complete and approved by the Soils Engineer.

- D. Hardened concrete, debris and foreign material shall be removed from interior of forms.

3.03 PLACING REINFORCEMENT

- A. Provide reinforcement for concrete slabs on grade as shown on the Drawings. Reinforcement shall be kept clean and free from objectionable rust. Bends or kinks in reinforcing bars shall be corrected before placing. All reinforcement shall be accurately located in forms and securely held in place, before and during concrete placing, by supports adequate to prevent displacement during the course of construction.
- B. Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.04 CONTRACTION JOINTS

- A. Provide contraction joints in concrete sidewalk T/4-inch-deep by 3/16 inches wide at 5-foot intervals, unless a more detailed jointing pattern is called for.
- B. For other contraction joints form by tooling or sawing a 1/4 inch wide joint T/4 inches deep in a checkerboard pattern. In no case shall the joints be greater than 10 feet in any direction.
- C. Joints shall be cut perpendicular to the surface and at right angles to the edge of pavement, unless a more detailed jointing pattern is called for.

3.05 EXPANSION (OR ISOLATION) JOINTS

- A. Provide expansion joints for concrete sidewalks and ramps at tangent points, radius returns, at intersections, and in straight runs at uniform intervals not exceeding 100 linear feet.
- B. Separate slabs on grade from vertical surfaces with 3/4 inch thick joint filler.
- C. Provide expansion joints between concrete pavement and adjacent rigid structures not specified herein before.

3.06 CONCRETE PLACING

- A. Unless indicated otherwise, concrete slabs on grade shall comprise of the following thickness:
 - 1. sidewalks: 4 inches thick
 - 2. sidewalks across drives: 6 inches thick
 - 3. sidewalk ramps: 6 inches thick
 - 4. residential driveways: 6 inches thick
 - 5. commercial/industrial driveways: 8 inches thick
 - 6. dumpster pads: 8 inches thick
- B. Concrete shall be handled from the point of delivery, to the concrete conveying equipment, and to the location of final deposit by methods, which will prevent segregation and loss of concrete mix materials. Handling will be in such a manner to ensure that the required quality of concrete is maintained.

- C. Before placing pavement, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- D. Cold-Weather concrete placement shall comply with ACI 306.1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- E. Hot-Weather concrete placement shall be according to recommendations in ACI 305R when hot-weather conditions exist.
- F. Equipment for Conveying Concrete:
 - 1. Runways for wheeled concrete conveying equipment shall be provided for the ready-mix concrete delivery point to the locations of final deposit.
 - 2. The interior surfaces of concrete conveying equipment shall be maintained free of hardened concrete, debris, water, snow, ice and other deleterious materials.
- G. When the temperature of steel forms is greater than 120-degrees F., the steel surfaces shall be sprayed with water just prior to placing the concrete.
- H. Concrete shall be deposited continuously. Concrete which has partly hardened or has been contaminated by foreign materials shall not be placed; such concrete shall be properly disposed of in an approved manner.
- I. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

3.07 CONCRETE FINISHING

- A. Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
- B. Float pavement surface by hand floating. Cut down high spots and fill low spots.
- C. Apply a light broom finish in a longitudinal direction to concrete slabs on grade

3.08 CURING CONCRETE

- A. Apply curing compound uniformly in continuous operation by power spray.
- B. Newly placed concrete shall be protected as required to maintain the temperature of the concrete at not less than 50 degrees F. nor more than 80 degrees F. and in a moist condition continuously for a period of time necessary for the concrete to cure.
- C. Changes in temperature of the concrete during curing shall be as uniform as possible and shall not exceed 5 degrees F. in any one hour, nor 50 degrees F. in any 24-hour period.

3.09 REMOVAL OF FORMS

- A. All forms, rails and stakes shall be removed within 48-hours after placing the pavement.
- B. Any and all "honey combing" noticed upon removal of the forms shall be hand grouted.

- C. Upon removal of the forms, the remaining excavated area shall be backfilled with approved material, compacted thoroughly, and left in a neat condition.

3.10 CLEANUP

- A. After completion of concrete curing in an area, remove all weather protection materials and rubbish and debris resulting from specified Work. Sweep concrete pavements clean.
- B. In no case shall the mixer or truck be flushed out onto the street pavement, in a catch basin or sewer manhole, or in any public right-of-way.

END OF SECTION

SECTION 32 14 13
CONCRETE PAVER MATERIALS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Concrete Pavers
 - 2. Joint Sand
 - 3. Setting Bed Sand
 - 4. Base Aggregate

1.02 REFERENCES

Note: Design street, industrial, port and airport pavement thicknesses in consultation with a qualified civil engineer, in accordance with established flexible pavement design procedures, LOCKPAVE® software, and in accordance with Interlocking Concrete Pavement Institute Technical Bulletins. Sample construction detail drawings are available from Unilock®. This specification may require modifications.

- A. ASTM International, latest edition:
 - 1. C 33, Standard Specification for Concrete Aggregates.
 - 2. C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 3. C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - 4. C 144 Standard Specifications for Aggregate for Masonry Mortar.
 - 5. D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - 6. C 936, Standard Specification for Solid Concrete Interlocking Paving Units.
 - 7. C 979, Standard Specification for Pigments for Integrally Colored Concrete.
 - 8. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.
 - 9. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.
 - 10. C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units
 - 11. D 2940 Graded Aggregate Material for Bases or Subbases for Highways or Airports.
 - 12. D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile

Note: In order to determine the latest version of the listed specifications and standards, please consult the ASTM web page (www.astm.com)

1.03 SUBMITTALS

- A. Concrete Pavers:

1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon project completion.
 2. Accepted samples become the standard of acceptance for the product produced.
 3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.
 4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.
- B. Joint and Setting Bed Sand:
1. Provide three representative one pound samples in containers of Setting Bed Sand materials.
 2. Test results from an independent testing laboratory for sieve analysis per ASTM C 136 conforming to the grading requirements of ASTM C 144.
- C. Polymeric Joint Sand:
1. Test results from an independent testing laboratory for sieve analysis per ASTM C 136 conforming to the grading requirements of ASTM C 144.
 2. Samples for Initial Selection: Provide three representative samples in containers of Polymeric Joint Sand material, cured and dried, for color selection.
 3. Samples for Verification: Provide three one pound samples in containers of Polymeric Joint Sand.
- D. Base and Subbase Aggregate:
1. Test results from an independent testing laboratory for sieve analysis per ASTM C 136.
- E. Paving Installation Contractor:
1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

1.04 QUALITY ASSURANCE

- A. Utilize a Manufacturer having at least ten years of experience manufacturing concrete pavers on projects of similar nature or project size.
- B. Source Limitations:
1. Obtain Concrete Pavers from one source location with the resources to provide products of consistent quality in appearance and physical properties.
 2. Obtain Joint and Setting Bed Sands from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.
 3. Obtain Polymeric Joint Sand from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Paving Contractor Qualifications:
1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.
- D. Mockups:
1. Install a 5 ft x 5 ft paver area per each paving pattern.
 2. Use this area to determine surcharge of the Setting Bed Sand layer, joint sizes, lines, laying pattern(s) and levelness. This area will serve as the standard by which the workmanship will be judged.
 3. Subject to acceptance by owner, mock-up may be retained as part of finished work.

4. If mock-up is not retained, remove and dispose legally.

1.05 DELIVERY, STORAGE & HANDLING

- A. In accordance with Conditions of the Contract and Division 1 Product Requirement Section.
- B. Deliver Concrete Pavers in manufacturer's original, unopened and undamaged container packaging with identification labels intact.
 1. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.
 2. Deliver Concrete Pavers to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.
 3. Unload Concrete Pavers at job site in such a manner that no damage occurs to the product or adjacent surfaces.
- C. Store and protect materials free from mud, dirt and other foreign materials.
- D. Prevent Joint and Setting Bed Sand from exposure to rainfall or removal by wind with secure, waterproof covering.
- E. Store Polymeric Joint Sand on elevated platforms, under a cover and/or in a dry location.

1.06 PROJECT/SITE CONDITIONS

- A. Environmental Requirements:
 1. Install Concrete Pavers only on unfrozen and dry Setting Bed Sand.
 2. Install Setting Bed Sand only on unfrozen and dry Base or Subbase Aggregate materials.
 3. Install Base or Subbase Aggregates only over unfrozen subgrade.
 4. Install Setting Bed Sand or Concrete Pavers when no heavy rain or snowfall are forecast within 24 hours.
- B. Weather Limitations for Polymeric Jointing Sand:
 1. Install Polymeric Joint Sand only when ambient temperature is above 40°F (5°C), under dry conditions with no rain forecast for 24 hours and when surface of pavement is completely dry.

1.07 CONCRETE PAVER OVERAGE AND ATTIC STOCK

- A. Provide a minimum of 5% additional material for overage to be used during construction.
- B. Contractor to provide 100 square feet of each product and size used to owner for maintenance and repair. Furnish Pavers from the same production run as installed materials.
- C. Manufacture to supply maintenance and reinstatement manuals for Concrete Paver units.

PART 2 PRODUCTS

2.01 CONCRETE PAVERS

- A. Basis-of-Design Product: The Concrete Paver shapes are based on:
 1. Unilock:
 - a. Treo Smooth Random Bundle 8 CM (Made to order)
 2. As manufactured by:
Unilock Brighton MI,
Contact: Shaun Breuer (248) 388 5833 – Shaun.Breuer@unilock.com
 3. Substitutions: No substitutions permitted.
- B. Product requirements:
 1. Concrete Paver Type 1: Unilock Treo Smooth Random Bundle 8 CM

- a. Finish: Umbriano
- b. Color: Summer Wheat
- c. Edge: Rounded
- d. Size: Random Bundle
- e. Pattern: Treo Smooth Fixed, or Treo Smooth Random Fixed_S

Note: Imperial dimensions are nominal equivalents to the metric dimensions.

- C. Provide pavers meeting the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence is not a cause for rejection.
 - 1. Average compressive strength 8000 psi (55MPa) with no individual unit under 7,200 psi (50 MPa).
 - 2. Average absorption of 5% with no unit greater than 7% when tested according to ASTM C 140.
 - 3. Conforming to ASTM C 1645 when tested for freeze-thaw requirements.
 - 4. Height tolerances +/- 3.2 mm (1/8 in).
- D. Accept only pigments in concrete pavers conforming to ASTM C 979.
Note: ACI Report No. 212.3R provides guidance on the use of pigments.
- E. Maximum allowable breakage of product is 5%.

2.02 POLYMERIC JOINT SAND

- A. Provide Polymeric Joint Sand as manufactured by: PolyBind
 - 1. PolyBind G2 Complete
 - a. Product Type: Dry mix, contains polymeric binding agent, activated with water.
 - b. Color: Oxford Grey, Naveda Tan, or Jet Black
 - 2. Supplier:
Unilock Michigan, Inc.
12591 Emerson Dr.
Brighton, MI 48116
Contact: Shaun Breuer– (248) 388-5833 Shaun.Breuer@unilock.com
- B. Provide Polymeric Joint Sand meeting the minimum material and physical properties as follows:
 - 1. Compression Strength: proven resistance to compression of 300 PSI minimum after drying for 7 days under controlled conditions (73°F (23°C) at 50% humidity).
 - a. Test sand sample shape: cylinder (2" (5 cm) dia. X 4" (10 cm) high).
 - 2. Gradation as shown Table 1 above.

2.03 SETTING BED SAND

- A. Provide Setting Bed Sand as follows:
 - 1. Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.
 - 2. Do not use limestone screenings, stone dust, or sand material that does not conform to the grading requirements of ASTM C 33.
 - 3. Do not use mason sand or sand conforming to ASTM C 144.
 - 4. Utilize sands that are as hard as practically available where concrete pavers are subject to vehicular traffic.
 - 5. Conform to the grading requirements of ASTM C 33 with modifications as shown in Table 2 below:

**TABLE 2 – SETTING BED SAND
GRADATION REQUIREMENTS FOR SETTING BED SAND**

MDOT 2NS	
Sieve Size	Percent Passing
3/8 in (9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	65 to 95
No. 16 (1.18 mm)	35 to 75
No. 30 (0.600 mm)	25 to 55
No. 50 (0.300 mm)	10 to 30
No. 100 (0.150 mm)	0 to 10
No. 200 (0.075)	0 to 1

2.04 BASE AGGREGATE

- A. Provide Base Aggregate materials conforming to ASTM D 2940 and gradation requirements as presented in Table 3.

**TABLE 3
BASE AGGREGATE
GRADATION REQUIREMENTS**

ASTM D 2940	
Sieve Size	Percent Passing
2 in (50 mm)	100
1-1/2 in (37.5 mm)	95 to 100
3/4 in (19 mm)	70 to 92
3/8 in (9.5 mm)	50 to 70
No. 4 (4.75 mm)	35 to 55
No. 30 (600 µm)	12 to 25
No. 200 (75 µm)	0 to 8*

* In order to prevent damage by frost heaving, it may be necessary to limit the percentages of material passing the No. 200 sieve to less than shown in the tables.

2.05 SUBBASE

- A. Provide Subbase Aggregate as designed per the structure engineer.
B. Insert gradation requirements here.

2.06 GEOTEXTILE

- A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:
1. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.
 2. Grab Tensile Strength: ASTM D 4632: 115 lbs.
 3. Grab Tensile Elongation: ASTM D 4632: 50%
 4. Trapezoidal Tear: ASTM D 4533: 50 lbs.
 5. Puncture: ASTM D 4833: 65 lbs.

6. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve
 7. Permittivity: ASTM D 4491: 2.0 sec -1
 8. Flow Rate: ASTM D 4491: 140 gal/min/s.f.
- B. As supplied
1. Carthage Mills – FX-40HS
 2. U.S. Fabrics
 3. Mirafi
- 2.07 Geo-Grid
- A. Provide Geo-Grid By: Unilock
1. Product: Unilock Drive Grid
 2. Supplier: Unilock Michigan, Inc.
12591 Emerson Dr.
Brighton, MI 48116
Contact: Shaun Breuer– (248) 388-5833 Shaun.Breuer@unilock.com
- 2.08 EDGE RESTRAINTS
- A. Plastic Edging where pavers meet Turf/ Landscaping.
1. Snap Edge By SEK
 2. a. Material Type: Plastic
 3. b. Model No.: One Piece Edging, 96 inches Long
 4. Install a minimum of 7-12” spikes per piece of edging
 5. Supplier: Unilock Michigan, Inc.
12591 Emerson Dr.
Brighton, MI 48116
Contact: Shaun Breuer– (248) 388-5833 Shaun.Breuer@unilock.com

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas indicated to receive paving for compliance with requirements for installation tolerances and other conditions affecting performance for the following items before placing the Concrete Pavers.
1. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
 2. Verify that Geotextiles, if applicable, have been placed according to drawings and specifications.
 3. Verify that the Base and Subbase Aggregate materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.
 4. Provide written density test results for soil subgrade, Base and Subbase Aggregate materials to the Owner, General Contractor and paver installation subcontractor.
 5. Verify location, type, and elevations of edge restraints, concrete curbing, concrete collars around utility structures, and drainage inlets.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Beginning of Bedding Sand and Concrete Paver installation signifies acceptance of Base and edge restraints.

3.02 PREPARATION

- A. Verify that the subgrade soil is free from standing water.
- B. Stockpile Setting Bed Sand, Joint Sand, Base and Subbase Aggregate materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.
- C. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Geotextile and Subbase Aggregate materials.
- D. Keep area where pavement is to be constructed free from sediment during entire job. Remove and replace all Geotextile, Joint Sand, Setting Bed Sand, Base and Subbase Aggregate materials contaminated with sediment with clean materials.
- E. Complete all subdrainage of underground services within the pavement area in conjunction with subgrade preparation and before the commencement of Base or Subbase Aggregate construction.
- F. Prevent to damage underdrain pipes, overflow pipes, observation wells, or inlets and other drainage appurtenances during installation. Report all damage immediately.
- G. Compact soil subgrade uniformly to at least 95 percent of Standard Proctor Density per ASTM D 698 for pedestrian areas. Compact soil subgrade uniformly to at least 98 percent Modified Proctor per ASTM D 1557 for vehicular areas. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils.
- H. Backfill all service trenches within the pavement area to the sub-grade level with approved material placed in uniform lifts not exceeding 4 in. (100 mm) loose thickness. Compact each lift to at least 100 percent Standard Proctor Density as specified in ASTM D 698.
- I. Trim the subgrade to within 0 to ½ in. (0 to 13mm) of the specified grades. Do not deviate the surface of the prepared subgrade by more than 3/8 in. (10mm) from the bottom edge of a 39 in. (1m) straight edge laid in any direction.
- J. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting and replace with compacted backfill or fill as directed.
- K. Do not proceed with further pavement construction, under any circumstances, until the subgrade has been inspected by the Architect/Engineer.

Note: Base compaction of the subgrade soil on the recommendations of the Design Engineer. Request the Architect/Engineer to inspect subgrade preparations, elevations and conduct density tests for conformance to specifications.

3.03 INSTALLATION

A. EDGE RESTRAINTS

- 1. Provide concrete edge restraints as indicated.
 - a. Install job-built concrete edge restraints to comply with requirements in Division 3 Section "Cast-in-Place Concrete."
 - b. Provide concrete edge restraint along the perimeter of all paving as indicated. Install the face of the concrete edge restraint, where it abuts pavers vertical down to the subbase.
 - c. Construct concrete edge restraint to dimensions and level specified and support on a compacted subbase not less than 6 in (150 mm) thick.
- 2. Provide plastic or metal edge restraints as indicated.

- a. Provide plastic or metal edge restraints along the perimeter of all paving as indicated and supported on a minimum of 6 inches (150 mm) of Base Aggregate.
 - b. Provide 10" spiral galvanized or stainless steel spike to fasten plastic edge restraint at 24 inches on center for straight sections and 12 inches on center for curved sections.
- B. GEOTEXTILES
 1. Provide separation geotextile on bottom and sides of prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.
 2. Overlap ends and edges a minimum of 18 in. (450 mm) in the direction of drainage.
- C. BASE AND SUBBASE AGGREGATE
 1. Provide the Subbase Aggregate in uniform lifts not exceeding 6 in., (150 mm) loose thickness and compact to at least 100 percent Standard Proctor Density as per ASTM D 698.
 2. Compact the Subbase Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
 3. Tolerance: Do not exceed the specified surface grade of the compacted Subbase Aggregate material more than $\pm 3/4$ in. (20 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
 4. Provide the Base Aggregate material in uniform lifts not exceeding 6 in. (150 mm) over the compacted Subbase Aggregate (or Subgrade) material and compact to at least 100 percent Standard Proctor Density as per ASTM D 698.
 5. Compact the Base Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
 6. Tolerance: Do not exceed the specified surface grade of the compacted Base Aggregate material more than $\pm 3/8$ in. (10 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
 7. Compact and grade the upper surface of the base sufficiently to prevent infiltration of the bedding sand into the base both during construction and throughout its service life. Blend segregated areas of the granular base by the application of crushed fines that have been watered and compacted into the surface.
- D. SETTING BED SAND
 1. Provide, spread and screed Setting Bed Sand evenly over the compacted Base Aggregate course.
 - a. Protect screeded Setting Bed Sand from being disturbed by either pedestrian or vehicular traffic.
 - b. Screed only the area which can be covered by pavers in one day.
 - c. Do not use Setting Bed Sand material to fill depressions in the base surface.
 2. Keep moisture content constant and density loose and constant until Concrete Pavers are set and compacted.
 3. Screed Setting Bed Sand using either an approved mechanical spreader (e.g.: an asphalt paver) or by the use of screed rails and boards. Maintain in a loose condition slightly ahead of the paving units and fully protect against incidental compaction following screeding. Loosen compacted sand by rain or screeded sand left overnight before further paving units are placed.

4. Inspect the Setting Bed Sand course prior to commencing the placement of the Concrete Pavers. Acceptance of the Setting Bed Sand occurs with the initiation of Concrete Paver placement.
- E. CONCRETE PAVERS
1. Replace Concrete Pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
 2. Mix Concrete Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures. (Color variation occurs with all concrete products. This phenomenon is influenced by a variety of factors, e.g. moisture content, curing conditions, different aggregates and, most commonly, from different production runs. By installing from a minimum of three (3) bundles simultaneously, variation in color is dispersed and blended throughout the project).
 3. Exercise care in handling face mix concrete pavers to prevent surfaces from contacting backs or edges of other units.
 4. Provide Concrete Pavers using laying pattern as indicated. Adjust laying pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.
 5. Use string lines or chalk lines on Setting Bed Sand to hold all pattern lines true.
 6. Set paver surface elevation a minimum of 3 mm (1/8 inch) to a maximum of 6 mm (1/4 inch) above adjacent drainage inlets, concrete collars or channels (provided the change in slope does not impede or alter the drainage or direction of flow).
 7. Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.
 - a. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
 8. Provide space between paver units of 1/32 in. (1 mm) wide to achieve straight bond lines.
 9. Prevent joint (bond) lines from shifting more than $\pm 1/2$ in. (± 13 mm) over 50 ft. (15 m) from string lines.
 10. Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
 11. Cut Concrete Pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
 12. Prevent all traffic on installed Concrete Pavers until Joint Sand has been vibrated into joints. Keep skid steer and forklift equipment off newly laid Concrete Pavers that have not received initial compaction and Joint Sand material.
 13. Vibrate Concrete Pavers into leveling course with a low-amplitude plate vibrator capable of a to 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
 - a. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
 - b. Compact installed Concrete Pavers to within 6 feet (2 meters) of the laying face before ending each day's work. Cover Concrete Pavers that have not been compacted and leveling course on which pavers have

not been placed, with nonstaining plastic sheets to prevent Setting Bed Sand from becoming disturbed.

14. Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.
15. Remove any cracked or structurally damaged Concrete Pavers and replace with new units prior to installing Joint Sand material.

F. JOINT SAND

1. Polymeric Joint Sand
 - a. Install Polymeric Joint Sand per manufacturers recommended instructions.

3.04 FIELD QUALITY CONTROL

- A. Verify final elevations for conformance to the drawings after sweeping the surface clean.
 1. Prevent final Concrete Paver finished grade elevations from deviating more than $\pm 3/8$ in. (± 10 mm) under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.
- B. Lippage: Paver-to-Paver Lippage:
 1. No greater than 3 mm (1/8 inch) difference in height between adjacent pavers.

3.05 REPAIRING, CLEANING AND SEALING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean.
 1. Clean Concrete Pavers in accordance with the manufacturer's written recommendations.

3.06 PROTECTION

- A. Protect completed work from damage due to subsequent construction activity on the site.

END OF SECTION

SECTION 32 14 13.19
PERMEABLE CONCRETE PAVER MATERIALS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Permeable Concrete Pavers
 - 2. Permeable Joint Opening Aggregate
 - 3. Permeable Joint Aggregate Type 1
 - 4. Permeable Joint Aggregate Type 2
 - 5. Permeable Setting Bed Aggregate (Open-graded)
 - 6. Permeable Base Aggregate (Open-graded)
 - 7. Permeable Subbase Aggregate (Open-graded)

1.02 REFERENCES

Note: Design street, industrial, port and airport pavement thicknesses in consultation with a qualified civil engineer, in accordance with established flexible pavement design procedures, LOCKPAVE® software, and in accordance with Interlocking Concrete Pavement Institute Technical Bulletins. Sample construction detail drawings are available from Unilock®. This specification may require modifications.

- A. ASTM International, latest edition:
 - 1. C 29 Bulk Density and Voids in Aggregate Materials.
 - 2. C 33, Standard Specification for Concrete Aggregates.
 - 3. C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 4. C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - 5. D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - 6. C 936, Standard Specification for Solid Concrete Interlocking Paving Units.
 - 7. C 979, Standard Specification for Pigments for Integrally Colored Concrete.
 - 8. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.
 - 9. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.
 - 10. C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units
 - 11. D 4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - 15. D 4491, Standard Test Method for Water Permeability of Geotextiles by Permittivity

Note: In order to determine the latest version of the listed specifications and standards, please consult the ASTM web page (www.astm.com)

1.03 SUBMITTALS

- A. Permeable Concrete Pavers:
 - 1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon project completion.
 - 2. Accepted samples become the standard of acceptance for the product produced.
 - 3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.
 - 4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.
- B. Permeable Joint Opening Aggregate:
 - 1. Provide three representative, one pound samples in containers of aggregate materials that indicate the range of color variation and texture expected upon project completion.
 - 2. Accepted samples become the standard of acceptance for the product produced.
 - 3. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C 136.
 - 4. Test results for void space percentage per ASTM C 29.
- C. Permeable Setting Bed, Base and Subbase Aggregate:
 - 1. Test results from an independent testing laboratory for compliance with ASTM D 448 No. 8, No. 57 and No. 2.
 - 2. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C 136.
 - 3. Test results for void space percentage per ASTM C 29.
- D. Paving Installation Contractor:
 - 1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

1.04 QUALITY ASSURANCE

- A. Utilize a Manufacturer having at least ten years of experience manufacturing interlocking concrete pavers on projects of similar nature or project size.
- B. Source Limitations:
 - 1. Obtain Permeable Concrete Pavers from one source location with the resources to provide products of consistent quality in appearance and physical properties.
 - 2. Obtain Permeable Joint Opening Aggregate from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Paving Contractor Qualifications:
 - 1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.
- D. Mockups:
 - 1. Install a 5 ft x 5 ft paver area.
 - 2. Use this area to determine joint sizes, lines, laying pattern(s) and levelness. This area will serve as the standard by which the workmanship will be judged.
 - 3. Subject to acceptance by owner, mock-up may be retained as part of finished work.
 - 4. If mock-up is not retained, haul offsite and dispose legally.

1.05 DELIVERY, STORAGE & HANDLING

- A. Deliver Permeable Concrete Pavers in manufacturer's original, unopened and undamaged container packaging with identification labels intact.
 - 1. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.
 - 2. Deliver concrete pavers to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.
 - 3. Unload pavers at job site in such a manner that no damage occurs to the product or adjacent surfaces.
 - B. Store and protect materials free from mud, dirt and other foreign materials.
- 1.06 PROJECT/SITE CONDITIONS
- A. Environmental Requirements:
 - 1. Install permeable pavers only on unfrozen permeable setting bed aggregate materials.
 - 2. Install permeable setting bed only on unfrozen permeable base and subbase aggregates.
 - 3. Install permeable base or subbase aggregates only over unfrozen subgrade.
- 1.07 PERMEABLE CONCRETE PAVER OVERAGE AND ATTIC STOCK
- A. Provide a minimum of 10% additional material for overage to be used during construction.
 - B. Furnish 200 square feet of each product and size used to owner for maintenance and repair. Furnish Permeable Concrete Pavers from the same production run as installed materials.
 - C. Manufacture to supply maintenance and reinstatement manuals for Permeable Concrete Paver units.

PART 2 PRODUCTS

- 2.01 PERMEABLE CONCRETE PAVERS
- A. Basis-of-Design Product: The permeable concrete paver shapes are based on:
 - 1. Unilock:
 - a. Treo Smooth Random Bundle 8 CM (Made to Order)
 - 2. As manufactured by:
 - Unilock
 - 12591 Emerson Dr.
 - Brighton MI
 - Contact: Shuan Breuer, 248 388 5833, Shaun.Breuer@unilock.com
 - 3. Substitutions: No substitutions permitted.
 - B. Product requirements:
 - 1. Concrete Paver Type 1: Unilock Trwo Smooth Random Bundle 8 CM
 - a. Finish: Umbriano
 - b. Color: Summer Wheat
 - c. Edge: Rounded
 - d. Size: Random Bundle
 - e. Pattern: Treo Smooth Fixed, or Treo Smooth Random Fixed_S
- Note: Imperial dimensions are nominal equivalents to the metric dimensions.

- C. Provide pavers meeting the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence is not a cause for rejection.
1. Average compressive strength 8000 psi (55MPa) with no individual unit under 7,200 psi (50 MPa).
 2. Average absorption of 5% with no unit greater than 7% when tested according to ASTM C 140.
 3. Conforming to ASTM C 1645 when tested for freeze-thaw requirements.
 4. Height tolerances +/- 3.2 mm (1/8 in).
- D. Accept only pigments in concrete pavers conforming to ASTM C 979.
Note: ACI Report No. 212.3R provides guidance on the use of pigments.
- E. Maximum allowable breakage of product is 5%.

2.02 PERMEABLE JOINT OPENING AGGREGATE

**TABLE 1 - ECO-OPTILOC
PERMEABLE JOINT OPENING AGGREGATE
GRADATION REQUIREMENTS
(CRUSHED LIMESTONE)**

ASTM No. 8	
Sieve Size	Percent Passing
1/2 in (12.5 mm)	100
3/8 in (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

- A. Provide Permeable Joint Opening Aggregate materials conforming to ASTM C 33 and gradation requirements as presented in Table 2.
- B. SEK Perm Chip
1. Color: Sunset Red
 2. Supplier: Unilock Michigan, Inc.
12591 Emerson Dr.
Brighton, MI 48116
Contact: Shaun Breuer— (248) 388-5833
Shaun.Breuer@unilock.com

**TABLE 2 - ECO-PRIORA & TOWN HALL
PERMEABLE JOINT OPENING AGGREGATE
GRADATION REQUIREMENTS
(GRANITE CHIPS)**

ASTM No. 9	
Sieve Size	Percent Passing
3/8 in (9.5 mm)	100
No. 4 (4.75 mm)	85 to 100
No. 8 (2.36 mm)	10 to 40

No. 16 (1.18 mm)	0 to 10
No. 50 (0.30 mm)	0 to 5

2.03 PERMEABLE SETTING BED AGGREGATE

- A. Provide Permeable Setting Bed Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 8 as presented in Table 3.

**TABLE 3
PERMEABLE SETTING BED AGGREGATE
GRADATION REQUIREMENTS**

ASTM No. 8	
Sieve Size	Percent Passing
½ in (12.5 mm)	100
3/8 in (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

2.04 PERMEABLE BASE AGGREGATE

- A. Provide Permeable Base Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 57 as presented in Table 4.

**TABLE 4
PERMEABLE BASE AGGREGATE
GRADATION REQUIREMENTS**

ASTM No. 57	
Sieve Size	Percent Passing
1-1/2 in (37.5 mm)	100
1 in (25 mm)	95 to 100
1/2 in (12.5 mm)	25 to 60
No. 4 (4.75 mm)	0 to 10
No. 8 (2.36 mm)	0 to 5

2.05 PERMEABLE SUBBASE AGGREGATE

- A. Provide Permeable Subbase Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 2 as presented in Table 5.

**TABLE 5
PERMEABLE SUBBASE AGGREGATE
GRADATION REQUIREMENTS**

ASTM No. 2	
Sieve Size	Percent Passing
3 in (75 mm)	100
2-1/2 in (63 mm)	90 to 100
2 in (50 mm)	35 to 70
1-1/2 in (37.5 mm)	0 to 15

3/4 (19 mm)	0 to 5
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Note: For all aggregates, provide washed, clean, have zero plasticity, free from deleterious or foreign matter, crushed, angular rock and contain no No. 200 sieve size aggregate materials used in the construction of permeable pavement. Aggregate materials serve as the structural load bearing platform of the pavement as well as a temporary receptor for the infiltrated water that is collected through the openings in the pavement's surface.

2.06 GEOTEXTILE

- A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:
 1. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.
 2. Grab Tensile Strength: ASTM D 4632: 115 lbs.
 3. Grab Tensile Elongation: ASTM D 4632: 50%
 4. Trapezoidal Tear: ASTM D 4533: 50 lbs.
 5. Puncture: ASTM D 4833: 65 lbs.
 6. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve
 7. Permittivity: ASTM D 4491: 2.0 sec -1
 8. Flow Rate: ASTM D 4491: 140 gal/min/s.f.
- B. As supplied by Unilock 12591 Emerson Dr, Brighton, MI 48116
 Contact: **Shaun Breuer**: Mobile: 248-388-5833
 1. Carthage Mills – FX-40HS
 2. U.S. Fabrics
 3. Mirafi
 4. Gator Fabric

2.07 EDGE RESTRAINTS

- A. Plastic and Metal Edge Restraints: where pavers meet Turf/ Landscaping.
 1. Permaloc, www.permaloc.com
 - a. Material Type: Aluminum
 - b. Model No.: 3 inch GeoEdge capture plate and geogrid
 2. SEK Surebond
 - a. Model No.: 8 feet PermEdge with attached geogrid
 3. Supplier: Unilock Michigan, Inc.
 12591 Emerson Dr.
 Brighton, MI 48116
 Contact: Shaun Breuer– (248) 388-5833
 Shaun.Breuer@unilock.com

2.08 DriveGrid (Optional depending on project needs)

- A. Provide Unilock DriveGrid geogrid.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas indicated to receive paving for compliance with requirements for installation tolerances and other conditions affecting performance for the following items before placing the Permeable Concrete Pavers.
 1. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.

2. Verify that Geotextiles, if applicable, have been placed according to drawings and specifications.
 3. Verify that Permeable Base and Subbase Aggregate materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.
 4. Provide written density test results for soil subgrade, Permeable Base and Subbase Aggregate materials to the Owner, General Contractor and paver installation subcontractor.
 5. Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage inlets.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Beginning of bedding sand and paver installation signifies acceptance of base and edge restraints.

3.02 PREPARATION

- A. Verify that the subgrade soil is free from standing water.
- B. Stockpile Permeable Setting Bed, Joint, Base and Subbase Aggregate materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.
- C. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Geotextile and Permeable Subbase Aggregate materials.
- D. Keep area where pavement is to be constructed free from sediment during entire job. Remove and replace all Geotextile, Permeable Joint, Setting Bed, Base and Subbase Aggregate materials contaminated with sediment with clean materials.
- E. Complete all subdrainage of underground services within the pavement area in conjunction with subgrade preparation and before the commencement of Permeable Subbase Aggregate construction.
- F. Prevent damage to underdrain pipes, overflow pipes, observation wells, or inlets and other drainage appurtenances during installation. Report all damage immediately.
- G. Compact soil subgrade uniformly to at least 90 percent of Standard Proctor Density per ASTM D 698 for pedestrian areas. Compact soil subgrade uniformly to at least 95 percent Modified Proctor per ASTM D 1557 for vehicular areas.
- H. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting and replace with compacted backfill or fill as directed.

Note: Base compaction and proof-rolling of the subgrade soil on the recommendations of the Design Engineer. Request the Architect/Engineer to inspect subgrade preparations, elevations and conduct density tests for conformance to specifications.

3.03 INSTALLATION

A. EDGE RESTRAINTS

1. Provide edge restraints as indicated.
 - a. Install job-built concrete edge restraints to comply with requirements in Division 3 Section "Cast-in-Place Concrete."
 - b. Provide concrete edge restraint along the perimeter of all paving as specified. Install the face of the concrete edge restraint, where it abuts pavers vertical down to the subbase.

- c. Construct concrete edge restraint to dimensions and level specified and support on a compacted subbase not less than 6 in (150 mm) thick.
- B. GEOTEXTILES
 1. Provide separation geotextile on bottom and sides of prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.
 2. Overlap ends and edges a minimum of 18 in. (450 mm) in the direction of drainage.
- C. PERMEABLE BASE AND SUBBASE AGGREGATE
 1. Provide the Permeable Subbase Aggregate in uniform lifts not exceeding 6 in., (150 mm) loose thickness and compact to at least 95 percent as per ASTM D 4254 to depths as indicated.
 2. Compact the Permeable Subbase Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
 3. Tolerance: Do not exceed the specified surface grade of the compacted Permeable Subbase Aggregate material more than $\pm 3/4$ in. (20 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
 4. Provide the Permeable Base Aggregate material in uniform lifts not exceeding 6 in. (150 mm) over the compacted Permeable Subbase Aggregate material and compact to at least 95 percent as per ASTM D 4254 to depths as indicated.
 - a. As indicated, provide Unilock DriveGrid geogrid material.
 - b. Place minimum 3 in. lift, compact Permeable Base Aggregate.
 - c. Place Unilock DriveGrid geogrid material. Overlap ends and edges a minimum of 18 in. (450 mm).
 5. Compact the Permeable Base Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the compaction device.
 6. Tolerance: Do not exceed the specified surface grade of the compacted Permeable Base Aggregate material more than $\pm 1/2$ in. (13 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
 7. Grade and compact the upper surface of the Permeable Base Aggregate material sufficiently to prevent infiltration of the Permeable Setting Bed Aggregate material both during construction and throughout its service life.
- D. PERMEABLE SETTING BED AGGREGATE
 1. Provide, spread and screed Permeable Setting Bed aggregate evenly over the Permeable Base Aggregate course.
 - a. Protect screeded Permeable Setting Bed Aggregate from being disturbed.
 - b. Screed only the area which can be covered by pavers in one day.
 - c. Do not use Permeable Setting Bed Aggregate material to fill depressions in the base surface.
 2. Keep moisture content constant and density loose and constant until Concrete Pavers are set and compacted.
 3. Inspect the Permeable Setting Bed Aggregate course prior to commencing the placement of the permeable concrete pavers.
 4. Inspect the Setting Bed Aggregate course prior to commencing the placement of the Permeable Concrete Pavers. Acceptance of the Setting Bed Aggregate occurs with the initiation of Permeable Concrete Paver placement.

E. PERMEABLE CONCRETE PAVERS

1. Replace unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
2. Mix Concrete Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures. (Color variation occurs with all concrete products. This phenomenon is influenced by a variety of factors, e.g. moisture content, curing conditions, different aggregates and, most commonly, from different production runs. By installing from a minimum of three (3) bundles simultaneously, variation in color is dispersed and blended throughout the project).
3. Exercise care in handling face mix pavers to prevent surfaces from contacting backs or edges of other units.
4. Provide Permeable Concrete Pavers using joint pattern as indicated. Adjust joint pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.
5. Use string lines or chalk lines on Permeable Setting Bed aggregate to hold all pattern lines true.
6. Set surface elevation of pavers 1/8 in. (3 mm) above adjacent drainage inlets, concrete collars or channels.
7. Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.
 - a. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
8. Provide space between paver units of 1/32 in. (1 mm) wide to achieve straight bond lines.
9. Prevent joint (bond) lines from shifting more than $\pm 1/2$ in. (± 15 mm) over 50 ft. (15 m) from string lines.
10. Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
11. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
12. Prevent all traffic on installed pavers until Permeable Joint Aggregate has been vibrated into joints. Keep skid steer and forklift equipment off newly laid pavers that have not received initial compaction and Permeable Joint Aggregate material. .
13. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a to 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
 - a. After edge pavers are installed and there is a completed surface.
 - b. Compact installed concrete pavers to within 6 feet (1,800 mm) of the laying face before ending each day's work. Cover pavers that have not been compacted and leveling course on which pavers have not been placed, with nonstaining plastic sheets to prevent Permeable Setting Bed Aggregate from becoming disturbed.
14. Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.
15. Remove any cracked or structurally damaged pavers and replace with new units prior to installing Permeable Joint Opening Aggregate material.

16. Provide, spread and sweep Permeable Joint Opening Aggregate into joints immediately after vibrating pavers into Permeable Setting Bed course until full. Vibrate pavers and add Permeable Joint Aggregate material until joints are completely filled, then remove excess surface material.
17. Remove excess Permeable Joint Aggregate broom clean from surface when installation is complete.

3.04 FIELD QUALITY CONTROL

- A. Verify final elevations for conformance to the drawings after sweeping the surface clean.
 1. Prevent final Concrete Paver finished grade elevations from deviating more than $\pm 3/8$ in. (± 10 mm) under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.
- B. Lippage: Paver-to-Paver Lippage:
 1. No greater than 3 mm (1/8 inch) difference in height between adjacent pavers.

3.05 REPAIRING, CLEANING AND SEALING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean.
 1. Clean Permeable Concrete Pavers in accordance with the manufacturer's written recommendations..

3.06 PROTECTION

- A. Protect completed work from damage due to subsequent construction activity on the site.

3.07 PERMEABLE JOINT AGGREGATE MATERIAL REFILLING

- A. **Remove all debris from joint and provide additional Permeable Joint Aggregate material after 120 days and before 150 days after date of Substantial Completion/Provisional Acceptance.**
 1. **Fill Permeable Joint Aggregate material full to the lip of the paver.**

4.08 LIFE CYCLE ACTIVITIES

- A. Paver cleaning: Clean Permeable Concrete Pavers as needed to remove staining, dirt, debris, etc.
 1. Clean per manufacturers recommendations.
- B. Maintenance: Permeable Joint Aggregate Material.
 1. Annually inspect Permeable Joint Aggregate material for areas clogged with debris.
 2. Vacuum or sweep as necessary to restore surface infiltration.
 3. Remove debris by vacuuming or sweeping Permeable Joint Aggregate
 - a. Replenish removed Permeable Joint Aggregate material with clean aggregate material flush to paver lip.
 - b. Sweep excess material from paver surface.

END OF SECTION

SECTION 32 33 00.1
EMERSON BICYCLE RACKS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Bicycle Rack.

1.2 REFERENCES

A. ASTM Testing Standards:

1. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
2. ASTM D 522 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
3. ASTM D 523 – Standard Test Method for Specular Gloss.
4. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
5. ASTM D 3359 – Standard Test Methods for Measuring Adhesion by Tape Test.
6. ASTM D 3363 – Standard Test Method for Film Hardness by Pencil Test.
7. ASTM G 155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

B. ISO Testing Standards:

1. ISO 1520 – Paints and Varnishes – Cupping Test.
2. ISO 2815 – Paints and Varnishes – Buchholz Indentation Test.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.
- B. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.
- C. Samples: Submit manufacturer's samples of materials, finishes, and colors.
- D. Warranty: Manufacturer's standard warranty.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer regularly engaged in manufacture of site furnishings since 1969.
- B. Product Support: Products are supported with complete engineering drawings and design patents.
- C. Base Worth: An installed base of products worth in excess of one hundred million dollars.
- D. Assets: Excess of twenty million dollars in assets.
- E. Production: Orders are filled within a 40-day schedule.
- F. Facility Operator: Welders and machine operators are certified.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area in accordance with manufacturer's instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.
- C. Handling: Protect materials and finish during handling and installation to prevent damage.

1.6 WARRANTY

A. Warranty Information:

-Products will be free from defects in material and/or workmanship for a period of three years from the date of invoice.

-The warranty does not apply to damage resulting from accident, alteration, misuse, tampering, negligence, or abuse.

- Landscape Forms, Inc. shall, at its option, repair, replace, or refund the purchase price of any items found defective upon inspection by an authorized Landscape Forms service representative.
- Purchasers should be aware that normal use of these high quality products can result in superficial damage affecting the finish. Scratches, nicks, and dents are to be considered normal wear and tear, and are not the responsibility of the manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Landscape Forms, Inc., 7800 E. Michigan Ave, Kalamazoo, Michigan 49048.
Phone: (800) 521-2546. Fax (269) 381-3455. Website www.landscapeforms.com
E-mail: specify@landscapeforms.com

2.2 BICYCLE RACKS

- A. "Emerson" Bicycle Rack
- B. Size:
 - Depth: 3-1/2 inches.
 - Height: 30-1/4 inches.
 - Length: 20 inches.
- C. Mounting:
 - 1. Embedded

2.3 MATERIALS

- A. Frame: Aluminum Casting – 319 ASTM B26 or 356 ASTM B108 & LFI 7.4.2-A1.
- B. Adjustable Leveler: Stainless steel round bar 303 ASTM A581, A582.
- C. Anchor Cover: Aluminum Casting – 319 ASTM B26 or 356 ASTM B108 & LFI 7.4.2-A1.
- D. Anchor Set Screw: 1/4-20 x 1" set screw, cup point, hex drive, magni-coated.
- E. Hardware Pack: Steel rod, 5/8-11 X 3 1/2 threaded rod with magni 565 – silver top coat, with thread patch.

2.4 ACCESSORIES

- A. Anchor Bolts: Corrosion resistant recommended (not supplied by manufacturer)

2.5 RECYCLED CONTENT

- A. Emerson Bicycle Rack:
 - Post-Consumer Material Content: Minimum 19 percent.
 - Pre-Consumer Material Content: Minimum 18 percent.
 - Recyclable: 100 percent.

2.6 FABRICATION

- A. Shop assembled bicycle rack.

2.7 FINISHES

- A. Finish on Metal: Landscape Forms, Inc. "Pangard II".
 - 1. Primer: Rust inhibitor.
 - 2. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
 - 3. Test Results: "Pangard II".
 - a. Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
 - b. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
 - c. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
 - d. Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
 - e. Erichsen Cupping, ISO 1520: 8 mm.

- f. Impression Hardness, Buchholz, ISO 2815: 95.
 - g. Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
 - h. Pencil Hardness, ASTM D 3363: 2H minimum.
 - i. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
 - j. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.
4. Color: Matte Black

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive racks.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Install level.
- C. Anchor securely in place.

3.3 ADJUSTING

- A. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
- B. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.4 CLEANING

- A. Clean rack promptly after installation in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that could damage finish.

3.5 PROTECTION

- A. Protect installed racks to ensure that, except for normal weathering, racks will be without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 32 33 00.2
SITE FURNISHINGS / SOCRATES BENCH

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Benches.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.
- B. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.
- C. Samples: Submit manufacturer's samples of materials, finishes, and colors.
- D. Warranty: Manufacturer's standard warranty.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer regularly engaged in manufacture of site furnishings since 1969.
- B. Product Support: Products are supported with complete engineering drawings and design patents.
- C. Base Worth: An installed base of products worth in excess of one hundred million dollars.
- D. Assets: Excess of twenty million dollars in assets.
- E. Production: Orders are filled within a 50-day schedule.
- F. Facility Operator: Welders and machine operators are certified.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area in accordance with manufacturer's instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.
- C. Handling: Protect materials and finish during handling and installation to prevent damage.

1.5 WARRANTY

- A. Warranty Information:
- Products will be free from defects in material and/or workmanship for a period of five years from the date of invoice.
 - The warranty does not apply to damage resulting from accident, alteration, misuse, tampering, negligence, or abuse.
 - Landscape Forms, Inc. shall, at its option, repair, replace, or refund the purchase price of any items found defective upon inspection by an authorized Landscape Forms service representative.
 - Purchasers should be aware that normal use of these high quality products can result in superficial damage affecting the finish. Scratches, nicks, and dents are to be considered normal wear and tear, and are not the responsibility of the manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Landscape Forms, Inc., 7800 E. Michigan Ave, Kalamazoo, Michigan 49048.
Phone: (800) 521-2546. Fax (269) 381-3455. Website www.landscapeforms.com
E-mail: specify@landscapeforms.com

2.2 BENCHES

- A. "Socrates" Benches
- B. Bench: 24" d x 18" h
1. 142" length

2.3 MATERIAL

- A. Cast stone (concrete): Manufacturer's proprietary blend of portland cement, sand, aggregate, and color admixture.
 - Use only one brand, type and source of cement for entire Project.
 - Provide integral colored concrete with lightfast (UV and fade resistant) color pigments.
- B. Water: Clean and potable.

2.4 RECYCLED CONTENT - Recyclable: 100 percent.

- A. Bench:
 - Post-Consumer Material Content: Minimum 0 percent.
 - Pre-Consumer Material Content: Minimum 0 percent.

2.5 FABRICATION

- A. Formwork: Fabricate forms sufficiently rigid to meet casting tolerances. Coat formwork with form release agent.
- B. Casting: Fabricate units to required profiles and sizes. Execute work accurately to specified tolerances and free of broken edges.
- C. Curing: Protect units from exposure to weather until concrete strength is adequate for form removal. Cure under identical conditions.

2.6 FINISHES

- A. Color: Charcoal Gray

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive benches.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 INSTALLATION

- A. Install benches in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Install benches level and plumb.

3.3 ADJUSTING

- A. Finish Damage: Contact manufacturer for assistance to repair minor damages to finish as approved by Architect.

3.4 CLEANING

- A. Clean benches promptly after installation in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that could damage finish.

3.5 PROTECTION

- A. Protect installed benches to ensure that, except for normal weathering, benches will be without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 32 84 00
PLANTING IRRIGATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Worm gear clamps for polyethylene pipe.
 - 3. Glue and Primer
 - 4. Sleeving.
 - 5. Sprinklers and nozzles
 - 6. Bubblers
 - 7. Two-wire cable and wire connectors.
 - 8. Surge arrestors and decoders.
 - 9. Grounding rod, clamp, and cable.
 - 10. Controller.
 - 11. Web-based controller software.
 - 12. Weather sensor.
 - 13. Isolation valves.
 - 14. Automatic control valves.
 - 15. Master Valve.
 - 16. Plastic ball valves.
 - 17. Quick coupling valves and stabilizers.
 - 18. Three elbow swing joints.
 - 19. Valve boxes for irrigation components.

1.03 DEFINITIONS

- B.
 - A. Lateral Piping: Downstream from control valves to sprinkler zones. Piping is under pressure during flow.
 - B. Retain first paragraph below unless drain valves discharge onto grade without downstream piping.
 - C. Mainline Piping: Downstream from point of connection to quick coupling valves and control valves. Piping is under pressure.
 - D. 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.
 - E. Sprinklers: Rotary and spray type, including nozzle as indicated in the legend.

- F. Flow Sensor: Provides irrigation system flow data back to the central controls.
- G. Isolation valve: Manual valve installed on the mainline pipe to isolate legs of the mainline for service.
- H. Quick coupling valve: Valve installed on mainline pipe to allow the connection of a hose.
- I. Automatic Control Valve: Valve installed on the mainline pipe that controls the operation of an irrigation zone.
- J. Controller: Irrigation system time clock. Controller opens and closes automatic control valves via low voltage wires to allow zone operation.

1.04 DESCRIPTION OF WORK

- A. Extent of irrigation system work is shown on the drawings and by provisions of this Section.
- B. The scope of work includes one point of connection for the irrigation system.
- C. The irrigation system shall be constructed using the sprinklers, automatic valves, quick coupling valves, isolation valves, piping, fittings, controllers, wiring, flow sensor, etc. of sizes and types as shown on the 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. Piping and valve locations shown on the drawings are essentially diagrammatic. Spacing of the sprinklers and quick coupling valves are shown on the drawings and shall be exceeded only with the permission of the Owner's Authorized Representative.
- 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, fittings, sprinklers, quick coupling valves, automatic control valves, controllers, electric wire, flow sensor, enclosures, isolation valves, and other necessary specialties and the removal and/or restoration of existing improvements, excavation and backfill, and all other work in accordance with plans and specifications as required for a complete system.

1.05 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be automatic operation with controller and automatic control valves.
- B. Location of irrigation valves, piping, and other system components: Design locations are approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of landscape areas indicated.
- C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:

1. All irrigation piping for mainline: Minimum 200 PSI.
2. Irrigation piping for lateral pipe: minimum 100 PSI.
3. Automatic control valves and isolation valves: 200 PSI.

1.06 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
1. All pipe and fittings.
 2. Worm gear clamps for polyethylene pipe.
 3. Glue and Primer
 4. Sleeving.
 5. Sprinklers and nozzles.
 6. Bubblers.
 7. Two-wire cable and wire connectors.
 8. Surge arrestors and decoders.
 9. Grounding rod, clamp, and cable.
 10. Controller.
 11. Web-based controller software.
 12. Rain sensor.
 13. Isolation valves.
 14. Automatic control valve.
 15. Flow sensor and master valve.
 16. Plastic ball valves.
 17. Quick coupling valves and stabilizers.
 18. Three elbow swing joints.
 19. Valve boxes for irrigation components.
- B. Operation and Maintenance Data: Submit operation and maintenance manuals for sprinklers, controllers and automatic control valves, and quick coupling valves.

1.07 QUALITY ASSURANCE

- F.
- 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 areas to be improved and to the areas allotted him by the Owner's Authorized Representative for material and equipment storage.
- D. The Contractor shall have a minimum of five years experience installing irrigation systems of comparable size and complexity.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends, both threaded and plain.

- B. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.
- D. Deliver irrigation system components in manufacturer's original undamaged and unopened containers with labels intact and legible.
- E. Store and handle materials to prevent damage and deterioration.
- F. Provide secure and locked storage for all brass, copper, bronze, and stainless-steel items including all valves, sprinklers, pipe fittings, wire, pipe, and similar components that cannot be immediately replaced, to prevent installation delays.

1.09 PROJECT CONDITIONS

- G.
 - A. Retain this article if interruption of existing water service is required.
- B. 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.
- C. 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 of equipment shall be done at the Contractor's expense.
- D. The exact location of existing utilities and structures and underground utilities are not indicated on the drawings; their locations shall be determined by the Contractor, 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.
- E. Minor adjustments in system layout will be permitted to clear existing fixed obstructions. Final system layout shall be acceptable to Owner's Authorized Representative.
- F. Landscaping shall supersede irrigation locations wherever there is a conflict between the two.

1.10 EXTRA MATERIALS

- H.
 - A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Quick coupling valve keys and hose swivels: Provide owner with valve key and hose swivel for use with quick coupling valve models installed as part of this work.
 - 2. Furnish keys for controller enclosure.

1.11 SERVICE AND MAINTENANCE

- I.
 - A. The Contractor shall service the system at the Owner's request during the guarantee period and shall be paid for work performed which is not covered by the guarantee.
 - B. After completion, testing and acceptance of the system, the Contractor will instruct the Owner's personnel in the operation and maintenance of the system.

1.12 OWNER'S ACCEPTANCE

- J.
 - 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. Provide a reproducible, 30"x 42" and 18" x 24" irrigation system record drawing showing valves, drains and pipelines including quick coupler and automatic valves.
 - 1. Legibly mark drawings to record actual construction.
 - 2. Locate horizontal locations, with a minimum of two dimensions to permanent surface improvements, for each automatic valve, isolation valve, all wire splice boxes, extra wire locations and quick coupling valve.
 - 3. Identify field changes with dimensions and details as required as well as changes made by Change Order.
 - 4.
 - D. Provide a zone identification drawing indicating with color, the different zones. Include table on drawing with zone description. Drawing shall be 18" x 24" laminated.
 - E. Final payment will not be made without the receipt of accurate as-built drawings and zone identification drawings by The Owner's Authorized Representative.
 - F. Provide one day to assist authorized manufacturer in downloading data and setting zone operation times for all zones on controller. Irrigation system will not be considered complete until control system is in complete working order.

1.13 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 thereby 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 the Owner.
- B. Contractor is to guarantee that all trenches and other disturbed areas be free from heaving or settling more than one-quarter inch (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.

- C. Contractor shall winterize the system the first year and return the following spring to energize the system.
- D. Prior to conclusion of the warranty period, return to site with landscape contractor and re-set irrigation zone operating times from "Establishment" times to "Normal Operation" times.

PART 2 - PRODUCTS

1.14 2.01 GENERAL

- A. All material 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 site.
- B. The Contractor shall use materials as specified. Material other than that specified will be permitted only after written application by the Contractor and written approval by the Owner's Authorized Representative. Substitutions will only be allowed when in the best interest of the Owner.

1.15 2.02 PIPE, SLEEVING, AND FITTINGS

- A. Pipe sizes shall conform to those shown on the drawings. 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.
- B. Provide pipe continuously and permanently marked with manufacturer's name or trademark, size, schedule, and type of pipe, working pressure at seventy-three (73) degrees Fahrenheit and National Sanitation Foundation (NSF) approval.
- C. All mainline piping and sleeves shall be ASTM D2241, rigid, unplasticized Polyvinyl chloride, extruded from virgin parent material. Provide pipe homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles, and dents.
- D. Mainline pipe transitioning between differing depths shall be completed by gradual pipe decent (trench cut deepening) or by using two 45-degree angle fittings. No 90-degree angle fittings are permitted for these transitions.
- E. All PVC pressure mainline pipe shall be Class 200 PVC, solvent weld.
- F. PVC pipe fittings shall be ASTM D2466 schedule 40 PVC molded fittings suitable for solvent weld, except all threaded PVC pipe fittings as noted on the drawings shall be ASTM D2467, schedule 80 PVC.
- G. Sleeves shall be Class 200 PVC with solvent weld joints for all sizes.
- H. Mark sleeve locations on the as-built drawing.

- I. Sleeves shall be installed 18" below walks. Sleeves shall be installed 30" beneath paving sub-base beneath drives and roadways.
- J. 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.
- K. All lateral pipe downstream of zone valves shall be ASTM 2239 flexible polyethylene pipe rated at 100 PSI working pressure, PE 3408.
- L. Fittings for polyethylene lateral pipe shall be ASTM D2609 insert type. Spears or Lasco. Saddle and cross fittings are not permitted.
- M. All polyethylene lateral pipe joints shall be secured with stainless steel band and screw worm gear clamps. Double clamp 1.5" and 2" pipe.

1.16 2.03 SPRINKLERS

- A. Refer to legend on irrigation detail sheet for type and nozzle required.
- B. 1-inch IPS sprinkler model to be as noted in the drawing legend and include three elbow swing joint with O-ring seals and 12" lay length as manufactured by Lasco, Spears, or Dura.
- C. Install all sprinklers 6" off walk and drive edges to prevent damage from snow removal equipment.

D. 2.04 WIRE, SURGE ARRESTORS, DECODERS AND WIRE CONNECTORS

- A. All wire shall be Type UL approved, for direct burial.
- B. Two-wire cable shall be size AWG fourteen (14) and be of the type approved for use by the controller manufacturer.
- C. Decoders shall be those specified by the control system manufacturer for the controller specified. All decoders shall be single station.
- D. Surge arrestors shall be installed at all "dead ends" and every 500 feet along the two-wire path as shown on the drawings. Grounding rod and cable shall be installed with surge arrestor inside valve box. Locations shall be shown on the as-built drawing.
- E. All two-wire cable shall be run next to the mainline pipe and inside sleeves beneath pavement crossings.
- F. Low voltage wire connectors to be made using wire nuts and 3M DBR/Y-6 connectors.
- G. One hundred and twenty volt (120 v) or heavier splices made underground are to be made using wire nuts and 3M brand Scotch-Lok DBR/Y-6 connectors.

H. 2.05 CONTROL SYSTEM

- A. Shall be two-wire, controller type as noted in the drawing legend and in notes on the plans.
- B. Controller shall include modules and software cards to connect to the manufacturer's central control system using cellular connection.
- C. Control system shall include flow meter and master valve connection to be connected to central control software.
- D. Control system shall include weather sensor installed controller cabinet.
- E. Control system shall include one year subscription for central control web-based control.
- F. All 110-volt wire and low voltage wire are to be installed in electrical conduit.
- G. 2.06 WEATHER SENSOR
- A. Weather sensor shall be as listed in the legend and be a wireless model.
- B. 2.07 ISOLATION VALVES
- A. Isolation valves to be gate valves, 600 PSI non-shock cold working pressure, conforming to federal specifications for its class.
- B. Valves shall be gate valve type with threaded ends.
- C. Manufacturer to be Leemco, Matco-Norca, or Nibco.
- D. 2.08 AUTOMATIC CONTROL VALVES
- A. Globe-type diaphragm valves of normally closed design, self-cleaning, with plastic bodies and covers and manual flow control. Operation shall be controlled by a slow-closing integrally mounted heavy-duty 24-volt AC solenoid complying with National Electrical Code, Class II Circuit; solenoid coil shall be completely waterproof, potted in epoxy resin within a plastic-coated stainless-steel housing.
- B. Valves are to be as noted in the legend, size as shown.
- C. Automatic valve assembly shall include plastic Spears or Lasco ball valve upstream of automatic valve. Size shall be the same as the automatic valve.
- D. 2.09 FLOW METER / MASTER VALVE
- A. The irrigation system shall have a flow meter and master valve installed capable of detecting flow on the irrigation system.
- B. Flow meter and master valve shall be installed per controller manufacturer requirements for the model controller and central control.
- C. Contact controller manufacturer to determine flow meter and master valve models for use with the specified control system software.

D. 2.10 QUICK COUPLING VALVE

- A. Quick coupling valves shall have cast brass bodies with spring-loaded, self-closing thermoplastic locking covers and 1-inch IPS inlet.
- B. Quick coupling valve model to be as noted in the drawing legend and include three elbow swing joint with o-ring seals and 12" lay length as manufactured by Lasco, Spears, or Dura.
- C. Install stabilizer on quick coupler body.
- D. Refer to detail on irrigation detail sheet. Support valve box with bricks on two opposing sides.
- E. Fill valve box with 12" of sand from 1" below top of quick coupler top. Pack in 2" lifts

F. 2.11 BACKFLOW PREVENTER:

- A. Backflow preventer to be furnished and installed by mechanical trades.
 - 1.

B. 2.12 VALVE BOXES

- A. Retain one of first two paragraphs below for access from grade to valves and devices. Revise material choices and insert features to suit Project. Do not use in roadways.
- B. Boxes in first paragraph should be used only in grass or paved areas subject to pedestrian traffic.
- C. 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.
- D. Valve box size shall be minimum 11" x 19", Carson or grounds personnel approved manufacturer.
- E. Provide lid of the same material, black in color.
- F. Side walls to extend at least two inches (2") below the bottom of the valve body; use extensions, as necessary.
- G. Support valve boxes with bricks on all four corners (rectangular) or two opposing sides (round).
- H. Accessories:
 - 1. Drainage fill to be sand.
 - 2. Fill shall be clean soil, free of stones larger than two inches (2") in diameter, foreign matter, organic material, and debris.

PART 3 - EXECUTION

A. 3.01 EXAMINATION

- B. Examine final grades and installation conditions. Do not start irrigation system work until unsatisfactory conditions are corrected.
- C. All city and state laws, rules and regulation governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications and their provisions shall be carried out by the contractor
- D. It is the responsibility of the irrigation contractor to familiarize himself with all grade differences, location of walls, retaining walls, structures, and utilities. The irrigation contractor shall repair or replace all items damaged by his work at no expense to the owner. He shall coordinate his work with other contractors for the location and installation of pipe sleeves and lateral lines through walls, under roadways, drives, and paving, etc.
- E. The contractor shall obtain the pertinent engineering, landscape, or architectural plans before beginning work.
- F. There are several utilities throughout the site. Have all utilities marked by the utility provider prior to initiating any work.
- G. The contractor shall obtain all necessary permits required to perform the work indicated herein before beginning work.
- H. Do not willfully install the sprinkler system as shown on the drawings when it is obvious in the field that unknown obstructions, grade differences or differences in the area dimensions exist that might not have been considered in the engineering. Such obstructions or differences should immediately be brought to the attention of the Owner's Authorized Representative. In the event this notification is not performed, the irrigation contractor shall assume full responsibility for any revisions necessary.
- I. Tree locations take priority over irrigation piping. Contact Owner's Authorized Representative to gain approval of pipe routing and installation method (trenching vs hand digging vs pipe pulling) within rootzone of trees.
- J. Obtain approval from Owner's Authorized Representative for all pipe routing and valve box locations throughout the site prior to initiating any work.
- K. Detroit General Services Department will finalize planting layout in the field prior to installation. Locations of plants will vary from those shown on the landscape plans.
- L. Final sprinkler locations and nozzle type will be based on final plant layout determined in the field by landscape contractor. Include time in the irrigation bid to make adjustments as directed by landscape contractor.
- M. 3.02 PREPARATION
- A. Consult with all trades and individuals to gain approval of positioning of the irrigation components including Owner's Authorized Representative, landscape architect, controller representative, and engineers to ensure that all components are placed in locations where they will operate most efficiently and not be in the way of utilities, plant material and other site components. Any items which are installed and later found to

need re-installation because approval was not granted by the knowledgeable party, will be done at the irrigation contractor's expense

- B. Set stakes to identify locations of proposed controller, piping, and valve boxes. Owner's Authorized Representative approval before excavation.
- C. Obtain latest manufacturer's recommended installation requirements for components. Any deviation between these specifications and plans and those recommendations are to be brought to the attention of the Owner's Authorized Representative.

D. 3.03 EXCAVATION 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 two-inch (2") depth of earth fill or sand bedding for piping when rock or other unsuitable bearing material is encountered.
- B. Fill to match adjacent grade elevation with approved earth fill material. Place and compact fill in layers not greater than eight-inch (8") depth.
- C. Provide approved fine grained earth fill or sand to a point four inches (4") above the top of pipe, as detailed on the irrigation detail sheet.
- D. Fill to within six inches (6") of final grade with approved excavated or borrow fill materials free of lumps or rocks larger than 2" in any dimension.
- E. The top six inches (6") of backfill shall be topsoil, free of rocks, subsoil, or trash. Any special soil mixture shall be replaced to the original condition it was prior to irrigation installation.
- F. Mechanically compact backfill in 6-inch lifts to a minimum of 95 percent (maximum density) under pavement and 90 percent in unpaved areas.
- G. Compacted backfill shall match surrounding grades. Repair of trench settlement and affected landscape shall be at Contractor's expense.
- H. All mainline pipe is to be installed using open trenches. Lateral pipe may be installed with vibratory plow if soil conditions permit.
- I. All trenches opened during any particular working day are to be backfilled the same day. Open or partially backfilled trenches left overnight or unsupervised shall be barricaded.
- J. Mechanically compact backfill in 6-inch lifts to a minimum of 95 percent (maximum density) under pavement and 90 percent in unpaved areas.
- K. Compacted backfill shall match surrounding grades. Repair of trench settlement and affected landscape shall be at the irrigation contractor's expense.

L. 3.04 PIPING INSTALLATION

- A. Install plastic pipe in accordance with manufacturer's installation instructions and ASTM D2274, particularly as it applies to thermal expansion and contraction.
- B. Store pipe such that it is protected from oil and grease and from prolonged exposure to sunlight and excessive heat.
- C. Solvent welding shall be in strict accordance with manufacturer's recommendations and ASTM Standards D2564 and D2855, especially as they apply to ambient temperature.
- D. Maintain interior free of dirt and debris. Close open ends of pipe by capping, taping or other acceptable method when pipe installation is not in progress, including overnight, to prevent to entrance of foreign matter.
- E. Pipe and fittings shall be handled in a manner to ensure delivery to the trench in sound, undamaged condition. If the coating of any pipe or fitting is damaged or if materials are in poor condition, it shall be repaired or replaced.
- F. Allow glued joints to set at least twenty-four hours before pressure is applied to the system.
- G. All mainline and contiguously pressurized pipe is to be installed using open trench and backfill.
- H. Minimum depth of cover over lateral pipe shall be twelve inches (12") and over mainline pipe shall be eighteen to twenty-four inches (18"-24").
- I. Option in first paragraph below may be withdrawn. If selecting, verify availability.
- J. Install piping in sleeves under parking lots, roadways, and sidewalks prior to paving. Minimum depth to be 18" beneath walks and drives, 30" beneath roadway subgrade.
- K. Where sleeves need to be installed beneath existing paving, open cut paving and repair per paving specifications for this project. Coordinate and pay for paving contractor to do all work associated with removing and repairing paving including the purchasing backfill material and paying paving contractor to backfill after the sleeves have been installed.
- L. Where more than one sleeve is to pass beneath paving, install sleeves 6" apart, as measured from the outside wall of the sleeves, in an even lateral layout. Do not install sleeves stacked on top of each other or rubbing against each other.
- M. Install sleeves made of Class 200 PVC pipe and socket fittings, and solvent-cemented joints.
- N. Remove existing mainline pipe encountered, remove from site, and properly dispose of it. If pipe cannot be removed in an area, contact Owner's Authorized Representative. If pipe is to remain based on conversation with Owner's Authorized Representative, cap ends of pipe to prevent collapse and label location on as-built drawing.

- O. All lateral pipe is to be new lateral pipe. Existing lateral pipe is to be removed from the site and properly disposed of.
- P. Maintain as-built drawing of mainline routing with lateral and vertical measurements at all changes of direction, isolation valve locations, sleeve crossings and every 100' along the mainline route.
- Q. 3.05 JOINT CONSTRUCTION
 - A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - C. 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.
 - D. Copper-Tubing Soldered Joints: Apply ASTM B 813 water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
 - E. PVC Piping Solvent-Cemented 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. 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.
 - F. 3.06 VALVE INSTALLATION
 - A. Electric valve installation shall be as indicated on the drawings. All electrical and manual valves shall be enclosed in a valve box. Add valve box manufactured extensions as required to prevent soil settlement around the valve. Set box flush with finish grade and aligned with adjacent boxes and/or adjoining sitework.
 - 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 minimum four blocks or bricks set under each corner or two bricks on opposing sides or round valve boxes to prevent box settlement. Refer to detail on irrigation detail sheet.
 - C. Install isolation valves on mainline pipe as detailed.

- D. Support valve box for isolation valves with minimum four blocks or bricks set under each corner to prevent box settlement.

- E. 3.07 SPRINKLERS

- A. Install sprinklers in accordance with manufacturer's recommendations and details on the irrigation detail sheet.

- B. 3.08 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

- A. The entire system to be a two-wire decoder system.
 - B. Equipment Mounting: new pedestal mount controller in location adjacent to water source connection point as approved by Owner's Authorized Representative.
 - 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - C. Obtain connection to control timer for communication to web-based controller.
 - D. The assistance of the manufacturer's authorized representative shall be made available for the final installation of the controller system and any other controller issues. 110vac power for the controller and related components shall be installed by a licensed electrical contractor. Final hookup of the power to the controller components shall be completed in the presence of the manufacturer's authorized representative.
 - E. Make final connection of 110-volt service to each timer. 110-volt service to timer location to be coordinated with electrical trades.
 - F. Install surge protection and grounding equipment as recommended by controller manufacturer. Test grounding and gain approval from controller manufacturer's representative that it is sufficient.
 - G. Install two-wire cable in same trench as irrigation piping and beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in sleeve under paved areas.
 - H. Install two-wire cable in the pipe trenches wherever possible.
 - I. Install two-wire cable with 24" of slack so as to provide for expansion and contraction. Expansion joints in wire may be provided at two-hundred-foot (200') intervals by making 5-6 turns of the wire around a piece of half inch (1/2") pipe. Where necessary to run wire in a separate trench, provide a minimum cover of twenty-four inches (24").
 - J. Provide minimum twenty-four-inch (24") slack at remote control valves to allow raising the valve bonnet or splice to the surface, without disconnecting the wire, for repair.
 - K. Provide minimum of 5'-0" of slack at all wire splices and spare wire locations. Neatly tape wire together using duct tape and coil it in a neat bundle within the valve box.

- L. 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.
- M. Make splices only at valve, unless otherwise unavoidable. Locate all field splices on the as-built drawing.
- N. All wire to be spliced using 3M scotch-lok or DBR/Y-6 connectors as detailed on the irrigation detail sheet.
- O. 3.10 FLUSHING AND TESTING
 - A. After all new irrigation piping is in place and connected for a given section and all necessary division work has been completed, and prior to the installation of sprinklers, all control valves shall be opened, and a full head of water used to flush out the system.
 - B. The sprinkler main shall be tested under normal water pressure (70 PSI) for a period of twelve hours. If leaks occur, repair, and repeat the test. Give Owner's Authorized Representative twenty-four hours' notice prior to testing.
 - C. 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.
 - D. Adjustment of the zone valves, sprinklers, and controller will be done by the Contractor upon completion of installation to provide optimum performance. Minor adjustments during the guarantee period will be made by the Owner.
- E. 3.11 FIELD QUALITY CONTROL
 - A. Flow meter/master valve and control timer: Engage a controller factory-authorized representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
 - 3. Central control and controllers: After master valve, flow sensor and controller have been installed and connected via cellular service to the central control computer, test system for complete and accurate operation.
 - 4. Provide one day to assist authorized manufacturer in downloading data and zone operation times for all zones on controller. Irrigation system will not be considered complete until control system is in complete working order.
 - 5. Test booster pump. Connect cellular remote software to cloud based control system.
 - 6. Test and adjust controls, pressure regulators and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Any irrigation product will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports for controller system.
- E. Obtain assistance from landscape contractor to set zone operation times.
- F. Set zones to operate so as to maintain adequate flow to allow flow sensor and master valve to operate properly.
- G. Where more than one zone valve is to be operated together, operate zones of similar plant material and exposure.
- H. Remove all extra material, piping, and packaging from site at conclusion of installation.
- I. Remove all excavated components from site, and properly dispose of them, at conclusion of installation.

END OF SECTION 328400

SECTION 32 91 13
SOIL PREPARATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including any General and/or Supplemental Conditions that may have been revised as part of the documents.

1.02 DESCRIPTION OF WORK

- A. The extent of earthwork is shown on drawings

1.03 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Standard Specifications: Michigan Department of Transportation (MDOT)
- C. Testing and Inspection Service
- D. Owner will engage soil testing and inspection service for quality control testing during earthwork operations.

1.04 SUBMITTALS

- A. Test Reports-Excavating: Submit following reports directly to Architect from the testing services, with copy to Contractor.
- B. Test reports on borrow material.
- C. Field density test reports

1.05 JOB CONDITIONS

- A. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.
- B. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
- C. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Architect and then only after acceptable temporary utility services have been provided.
- D. Provide minimum of 48-hour notice to Architect and received written notice to proceed before interrupting any utility.
- E. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- F. Perform excavation within drip-line of large trees to remain by-hand, protecting the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and large with emulsified asphalt tree paint.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. Definitions

1. Satisfactory soil materials: Those complying with American Association of State Highway and Transportation Officials (AASHTO) M145, soil classification Groups A-1, A-3 as directed by Soils Engineer. Onsite materials that meet these requirements and are approved by Soils Engineer are acceptable.
2. Unsatisfactory soil materials: Those defined in AASHTO M145 soil classification A-2-6, A-2-7 and A-7; also, peat and other highly organic soils.
3. Cohesionless soil materials: include gravels, sand-gravel mixtures, sand and gravelly sands.
4. Cohesive soil materials: include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts and very fine sands.

2.02 BASE MATERIALS

A. Backfill and Fill Materials:

1. Satisfactory soil materials free of clay, rock or gravel larger than 2" in any dimension, debris, waste, frozen materials, vegetable and other deleterious matter as directed by soils engineer.

PART 3 EXECUTION

3.01 BACKFILL AND FILL

- A. Place acceptable soil material in layers to require subgrade elevations, for each area classification listed below.
- B. Under grassed areas, use satisfactory excavated or borrow material.
- C. Backfill against building walls, use sand fill to 6" below finish grade.
- D. Under steps, use sand fill material.
- E. Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth for material compacted by heavy compaction equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers. Use only hand-operated equipment behind completed retaining walls.

3.02 GRADING

- A. Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
- B. Perform grading 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.
- C. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding.
- D. Finish surfaces free from irregular surface changes, and as follows:

1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations. Allow for 4" average depth of topsoil at lawn areas, and depth at planting areas as shown on landscape drawings, except as otherwise indicated on drawings.
 2. Walks: Shape surface of area under walks to line, grade and cross-section, with finish surface not more than 0.10' above or below required subgrade elevation.
- E. Grading at existing trees to remain:
1. Perform grading, within branch spread of existing trees to remain, by hand methods to elevations indicated.
 2. Cut roots cleanly to depth 3" below proposed finish grade. Coat cut roots with tree paint.

3.03 FINISH GRADING

- A. Uniformly distribute and spread topsoil. Provide 4" average depth at lawn areas, at planting areas shown on landscape drawings. Provide additional imported topsoil as required to complete the work. Do not use frozen or muddy topsoil. Place during dry weather.
- B. Fine grade topsoil eliminating rough and low areas to ensure positive drainage. Maintain levels, profiles, and contours of subgrades.
- C. Remove stones, roots, weeds, and debris while spreading topsoil materials. Rake surface clean of stones 1" or large in any dimension and all debris. Provide surfaces suitable for soil preparation provided under lawn and planting work.
- D. Manually install topsoil at trees to remain. Avoid damage to root systems.

3.04 MAINTENANCE

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.
- D. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.

3.05 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal from Owner's Property:
 1. Remove excess excavated material, trash, debris, waste and unsuitable materials and dispose of it off Owner's property.

END OF SECTION

SECTION 32 92 19
SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparation of subsoil
- B. Placing topsoil
- C. Seeding, hydroseeding, mulching and fertilizer
- D. Maintenance

1.02 REFERENCED SECTIONS

- A. Section 01 31 00 Project Management and Coordination
- B. Section 31 05 13 Soils for Earthwork

1.03 REFERNCES

- A. FS 0-F-241 - Fertilizers, Mixed, Commercial.
- B. Michigan Department of Transportation - MDOT
 - 1. 2003 Standard Specifications for Construction.

1.04 DEFINITIONS

- A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.05 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging and location of packaging.

1.06 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

1.07 DELIVERY, STORAGE and HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01 60 00.
- B. Deliver grass seed mixture in sealed containers. Seed in damaged packing is not acceptable.
- C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.08 COORDINATION

- A. Coordinate work under provisions of Section 01 31 00.

PART 2 PRODUCTS

2.01 SEED MIXTURE

A. Seed Mixture:

- | | | |
|----|----------------------------|-----|
| 1. | Kentucky Blue Grass: | 30% |
| 2. | Creeping Red Fescue Grass: | 40% |
| 3. | Perennial Rye Grass: | 30% |

2.02 SOIL MATERIALS

A. Topsoil: As specified in Section 31 05 13.

2.03 ACCESSORIES

- A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life and dry. Hay or chopped cornstalks are not acceptable.
- B. Fertilizer: FS O-F-241, Type I, Grade A; recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:
 - 1. Nitrogen 33 percent, phosphoric acid 33 percent, soluble potash 33 percent.
- C. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of grass.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared soil base is in accordance with Section 01 31 00 and is ready to receive the work of this Section.

3.02 PLACING TOPSOIL

- A. Place topsoil in areas where seeding, sodding and/or planting to a nominal depth of 6 inches. Place topsoil during dry weather.
- B. Fine grade topsoil eliminating rough or low areas. Maintain profiles and contour of subgrade.
- C. Remove roots, weeds, rocks and foreign material while spreading.
- D. Manually spread topsoil close to trees, plants, building and structures to prevent damage.
- E. Lightly compact placed topsoil.
- F. Remove surplus subsoil and topsoil from site.
- G. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.03 TOLERANCES

- A. Top of Topsoil: Plus or minus half inch.

3.04 PROTECTION

- A. Protect landscaping and other features remaining as final work.
- B. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.

3.05 SCHEDULES

- A. Compacted topsoil thickness at the following areas:
 - 1. Seeded Grass: 6 inches.
 - 2. Sod: 4 inches
 - 3. Shrub Beds: 12 inches
 - 4. Flower Beds: 12 inches
 - 5. Planter Boxes: To within 3 inches of box rim.

3.06 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions at a rate of 240 pounds per acre.
- B. Apply after smooth raking of topsoil.
- C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- D. Mix thoroughly into upper 2 inches of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.07 SEEDING

- A. Apply seed at a rate of 100 lbs per acre evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- D. Immediately following seeding, apply mulch to a thickness of 1/8 inch. Maintain clear of shrubs and trees.
- E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

END OF SECTION

SECTION 32 93 00
PLANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provide trees, plants and ground covers as shown and specified. The work includes:
 - 1. Soil Preparation
 - 2. Trees, Plants, and Ground Covers
 - 3. Planting Mixes
 - 4. Mulch and Planting Accessories

1.02 REFERENCES

- A. STM: American Society for Testing Materials.
- B. American Standard for Nursery Stock ANSI Z60.1-1980; American Association of Nurserymen, Inc. 835 Southern building, Washington, D.C.
- C. Scandalized Plant Names, 1942 edition, American Joint Committee on Horticulture Nomenclature.

1.03 DEFINITIONS

- A. Weeds: Includes, but not limited to: Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Weed, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Plants: Living trees, plants and ground cover specified in this Section, and described in ANSI Z60.1.

1.04 MAINTENANCE DATA

- A. Operations Data: Submit for continuing Owner maintenance.
- B. Maintenance Data: Include cutting and trimming method; types, application frequency, and recommended coverage of fertilizer and watering.

1.05 QUALITY ASSURANCE

- A. Plant names indicated, comply with "Standard Plant Names" as adopted by the latest edition of the American Joint Committee of Horticulture 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 dimensional 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 or a minimum of two (2) years.
- D. Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable, at no additional cost, and providing that the larger plants will not be cut back to size indicated. Provide plants indicated by two measurements so that

only a maximum of 25% are the minimum size indicated and 75% are of the maximum size indicated.

- E. Provide “specimen” plants with a special height shape or character of growth. Tag specimen trees or shrubs at the source of supply. The engineer will inspect the 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.
- F. As indicated on the plant list, Engineer shall select and tag trees at place of growth. Contractor shall have previously inspected trees at place of growth for compliance with specifications. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.

1.06 QUALIFICATIONS

- A. Nursery: Company specializing in growing and cultivating the plants with three (3) years documented experience.
- B. Installer: Company specializing in installing and planting the plants with three (3) years documented experience approved by nursery.
- C. Maintenance Services: Performed by installer and owner.

1.07 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of plants, fertilizer and herbicide mixture.
- C. Plant Materials: Certified by state department of agriculture as described by ASTM Z60.1; free of disease or hazardous insects.

1.08 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-Desiccant” 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, the certificate shall be filled with the Engineer. 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 Engineer. Water heeled-in plantings daily. No plant shall be wound 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 wind burn.
- D. Provide dry, loose topsoil for planting bed mixes. Frozen or muddy topsoil is not acceptable.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Do not install plant life when ambient temperature may drop below 35°F or above 90° F.

- B. Do not install plants when wind velocity exceeds 30 mph.

1.10 COORDINATION

- A. Work notification: Notify Engineer 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.
- C. Plant names and sizes are shown on the drawings. In the event that quantity discrepancies or material omission occur, the planting plans shall govern.

1.11 WARRANTY

- A. Provide a two-year warranty.
- B. Warranty: Include coverage for two continuous growing seasons; replace dead or unhealthy plants.
- C. Replacements: Plants of the same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

1.12 MAINTENANCE SERVICE

- A. Maintain plant life immediately after placement until plants are well established and exhibit a vigorous growing condition and beginning of maintenance of owner.
- B. Maintenance to include:
 - 1. Cultivation and weeding planting beds and tree pits.
 - 2. Applying herbicides for weed control in accordance with manufacturer's instructions.
 - 3. Remedy damage resulting from use of herbicides.
 - 4. Remedy damage from use of insecticides.
 - 5. Irrigating sufficient to saturate root system.
 - 6. Pruning, including removal of dead or broken branches, and treatment of pruned areas or other wounds.
 - 7. Disease control.
 - 8. Maintain wrapping, guys, trunkbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

PART 2 PRODUCTS

2.01 TREES, PLANTS, AND GROUND COVER

- A. Plants: Provide plant 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, sun scaled injuries, frost cracks, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation. All plants shall have fully developed from without voids and open spaces. Plants held in storage will be rejected if they show signs of growth during storage.
- B. 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 comply with the latest edition of

the "American Standard for Nursery Stock". Cracked or mushroomed balls are not acceptable.

- C. 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.
- D. No plants shall be loose in the container.
- E. Container stock shall not be pot bound.
- F. Provide tree species that mature to heights over 25' - 0" with a single main trunk. Trees that have a min trunk forming a "Y" shape are not acceptable.
- G. Plants planted in rows shall be matched in form.
- H. Plants larger than those specified in the plant list may be used when acceptable to the engineer.
- I. If the use of larger plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.
- J. The height of the trees, 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 plant list.
- K. No pruning wounds shall be present with a diameter of more than 1" and such wounds must show vigorous bark on all edges.
- L. Evergreen trees shall be branched to the ground.
- M. Shrubs and small plants shall meet the requirements for spread and height indicated in the plant list.
 - 1. The measurements for height shall be taken from the ground level to the average height of the plant and not the longest branch.
 - 2. Single stemmed or thin plants will not be accepted.
 - 3. Side Branches shall be generous, well-twiggged, and the plant as a whole well-bushed to the ground.
 - 4. Plants shall be in moist, vigorous condition, free from dead wood, bruises, or other root or branch injuries.

2.02 SOIL AMENDMENT MATERIALS

- A. Fertilizer: Commercial complete standard product complying with State and Federal Fertilizer laws.
- B. Deliver to site in original unopened containers with manufacturers guaranteed statement of analysis or furnish Engineer with manufacturer's certificate of compliance covering analysis.
- C. Fertilizer shall be 10-6-4 composition by weight - Nitrogen 10%, Available Phosphoric Acid (P205) 6%, and Water-Soluble Potash (K20) 4%.
- D. At least 50% by weight of nitrogen content shall be derived from organic materials.
- E. Fertilizer shall be uniform in composition, free flowing and suitable for application with approved equipment.
- F. Contractor may substitute enriched bovine or equine droppings if adequate fumigatory protection is provided.
- G. Peat moss: Ground and shredded horticultural grade moss peat, supplied in bales from commercial source. Acidity shall be ph. 4.0 - 7.0. It shall contain not

less than 90% organic matter by weight on oven-dry basis. It shall contain no less than 35% and no more than 55% moisture by weight. Ash content shall not exceed 10%.

- H. Bone Meal: Raw, finely ground, commercial grade, minimum of 3% nitrogen and 20% phosphorous.
- I. Lime: Ground limestone, dolomite type, minimum 95% carbonates.
- J. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of plants.
- K. Herbicide: As required by nurseries.
- L. Pesticides: As required by nurseries.

2.03 MULCH MATERIALS

- A. Shredded bark mulch: Shall consist of either mixed hardwood species or pine alone. Sixty (60) percent of shredded bark particles shall range between one (1) and three (3) inches in length; remaining forty (40) percent shall be less than one (1) inch in length. Maximum width of particles shall not exceed 1- 1/2 inches. Minimum depth of bark mulch shall be 4".

2.04 ACCESSORIES

- A. Anti-Desiccant: Emulsion that, when applied, forms transparent protective film over plant surface, permeable enough to permit transpiration. WILT PRUF, manufactured by Nursery Specialty Products, Inc., or approved equal.
- B. Stakes: 2 x 2 wood, pointed at one end; length as required to extend 18" below bottom of tree ball or root base of item being staked.
- C. Guy Wire: 11-gauge pliable, galvanized guying wire.
- D. Tree Wrap: Heavy 4" wide brown kraft with bituminous inner coating manufactures by W.E. Clark and Son, Orane, Connecticut or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared subsoil is ready to receive work.
- B. Saturate soil with water to test drainage

3.02 PREPERATION OF SUBSOIL

- A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
- C. Scarify subsoil to a depth of 3 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
- D. Dig pits and beds 6 inches larger than plant root system.

3.03 PLACING TOPSOIL

- A. Spread topsoil to a minimum depth of 6 inches over area to be planted.
- B. Place topsoil during dry weather and on dry unfrozen subgrade.

- C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
- D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
- E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches.

3.04 INSTALLATION

A. General:

- 1. Transplanting shall be performed by professional familiar with accepted procedure of transplanting under supervision of qualified transplanting foreman.
- 2. Unless otherwise directed by Engineer, indication of plants on Drawings is to be interpreted as including digging of hole, furnishing plant of specified size, work of transplanting, mulching, guying, staking and wrapping.
- 3. Contractor shall inform Engineer 24 hours before making any delivery of plant material. Each shipment shall be accompanied by invoice showing sizes and varieties included. Copy of invoice shall be filed with Engineer upon delivery of plant material.
- 4. Location of plants and outlines for transplanting beds shall be staked on ground before digging begins. Adjustments in locations and outlines shall be made as directed. In the event that pits or areas for transplanting are prepared and backfilled with topsoil to grade prior to commencement of law operations, they shall be so marked that when work of transplanting proceeds, they can be readily located.
- 5. If stone, underground construction work, tree roots, poor drainage or other obstructions are encountered during excavation of tree pits, alternate locations may be selected by Engineer. Where locations cannot be changed as determined by Engineer, submit cost required to remove obstructions to depth of not less than 6" below required pit depth. Proceed with work after approval of Engineer.
- 6. Holes of trees shall be at least one foot greater in diameter than spread of root ball and at least 6" deeper than root ball. Holes for shrubs and vines shall be at least 6" greater in diameter than the spread of root ball or plant container and at least 6" deeper than root ball or plant container.
- 7. Transplanting soil shall be composed of four (4) parts topsoil well mixed with one (1) part peat moss.
- 8. All plant beds and all other areas noted on Plans shall have landscape mat installed throughout transplanting beds between soil and back mulch (except in annual transplanting areas). Mat shall be installed snug against edging with 3" space around individual plants. Lap all joints at least three (3) inches.

3.05 INSTALLING PLANTS

- A. Plant roots and earth balls shall be kept damp and thoroughly protected from sun and drying winds at all times. Plants shall be planted in center of holes at same depth as they previously grew. Planting soil shall be backfilled in layers of not

more than 9" and each layer tamped before next layer is put in place. Enough topsoil shall be used to bring surfaces to finish grade when settled.

- B. Cut ropes or strings from top of ball after plant has been set. Leave burlap wrapping intact around balls. Turn under and bury portions of burlap exposed at top of ball.
- C. Provide saucer around each plant as shown on Drawings.
- D. Saturate plant pits with water within 24 hours after planting.

3.06 PRUNING

- A. Plants shall not be pruned prior to delivery unless Engineer gives written permission. Pruning shall be executed only to preserve natural character of plant and in appropriate manner particular to each plant's design requirements. Amount of pruning shall be limited to not to exceed 33% of total plant as necessary to remove dead or injured twigs and branches, and to compensate for root loss resulting from transplanting. Do not cut leaders.
- B. Pruning shall be done with clean, sharp tools according to standard horticultural practices. Cuts shall be made flush leaving no stubs.
- C. Cuts over 1/2" diameter shall be painted over with approved tree paint. Paint shall cover all exposed living tissues. Injured cambium on bruises and scars shall be tracked back to living tissues and removed. Smooth and shape wounds so as not to retain water. Treat wound with paint.

3.07 WRAPPING

- A. Trunks of deciduous trees. 1-1/2" caliper and larger, shall be wrapped immediately after planting. Wrap trunk spirally from ground up to lowest branch and tie wrapping securely in place.

3.08 MULCHING

- A. Apply fertilizer evenly over plant bed at rate of one pound per 100 square feet of bed areas. Provide mulch over fertilized surfaces of saucers and over entire area of shrub bed as shown on Drawings.

3.09 STAKING AND GUYING

- A. Stake trees taller than 4'-0" and less than 4-1/2" diameter. Place stakes adjacent to outside of ball and drive vertically to depth of 18" below bottom of ball. Attach tree to stake with 11-gauge guying wire. Portion of wire in contact with tree shall be encased in 1/2" I.D. reinforced rubber hose. Use two (2) stakes for trees up to 2-3/4" in caliper and three (3) stakes for trees 3" to 4-1/2" in caliper. Trees that have blown down, sway excessively, or are otherwise injured because of improper bracing shall be replaced at the Contractor's expense.

END OF SECTION

SECTION 32 93 01
CORTEN METAL EDGING

1.0 MATERIALS

- A. EDGE RIGHT METAL EDGING – 4" HEIGHT
- B. COR-TEN A606 Type-4 (weathering steel), 14" height, 16-Gauge Thickness
- C. Tensile Strength, min, (MPa) 65 (450)
- D. Yield Strength, min, kis (MPa) 45 (310)
- E. Corrosion-Resistance index of 6.0 (ASTM G101)
- F. COR-TEN known for its enhanced corrosion resistance and protective patina formation, can offer reliable performance over several decades when properly installed in suitable environments. Actual lifespan may vary depending on environmental conditions.

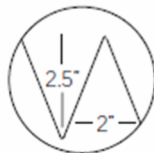
2.0 FEATURES

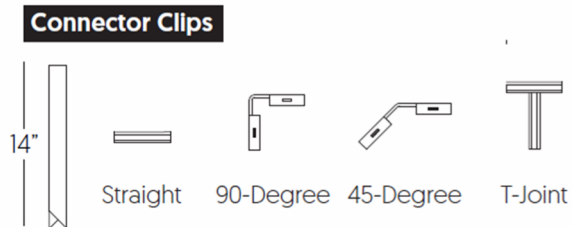
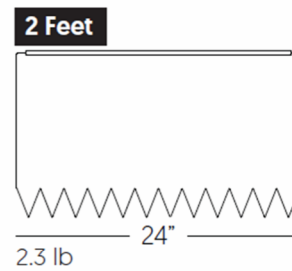
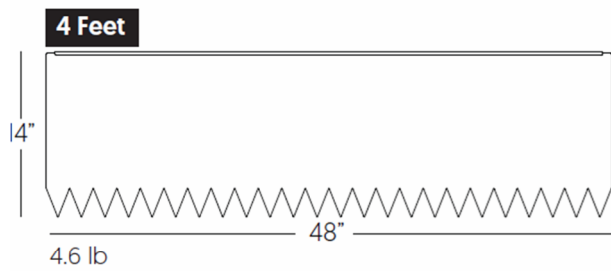
- A. Flexible design allows for easy bending into any shape or landscape configuration.
- B. Highly durable and long-lasting, resistant to pests, weathering, and physical damage.
- C. Features serrated teeth that effortlessly grip the ground for secure installation.
- D. 1/4" rolled top ensures smooth, seamless connections between edging strips.

3.0 INSTALLATION

- A. Use an edger or shovel to loosen the soil and define the path where the edging will be installed.
- B. Position the edging with the teeth facing down along the defined plath.
- C. Place e wood block over the spine of the edging and hammer it down a minimum of 3" inches
- D. Place the edging end-to-end, then separate the clamp on top of the pieces and drive it down to secure the clamp.

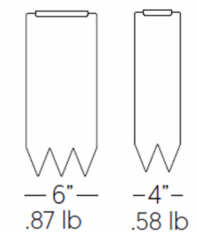
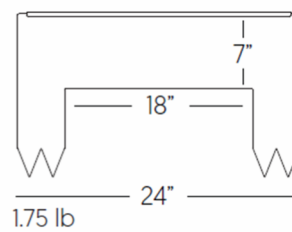
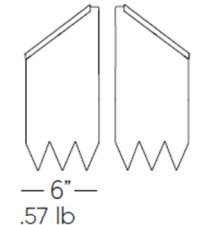
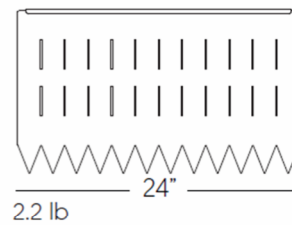
Teeth Dimensions 1/4" Rolled top





edgeright.com
info@edgeright.com

231 Berry Street
Berry, AL 35546



SECTION 33 05 61
CONCRETE MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Modular precast concrete manhole sections with tongue-and-groove joints with masonry transition to lid frame, covers, anchorage and accessories.

1.02 REFERENCED SECTION

- A. Section 01 31 00 - Project Management and Coordination

1.03 REFERENCES

- A. ASTM International. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.
 - 1. ASTM C55 - Standard Specification for Concrete Brick
 - 2. ASTM A48 - Standard Specification for Gray Iron Castings.
 - 3. ASTM C478 - Specification for Precast Reinforced Concrete Manhole Sections.
 - 4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 - 5. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
- B. International Masonry Industry All-Weather Council (IMIAC): Recommended Practices and Guide Specification for Cold Weather Masonry Construction.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 50 degrees F (10 degrees C) prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Manhole Sections with modified Groove Tongue Joints: Reinforced precast concrete as specified in plans with ASTM C478 with gaskets in accordance with ASTM C443.

2.02 COMPONENTS

- A. Lid and Frame: ASTM A48, Class 30B Cast iron construction, machined flat bearing surface, removable open checkerboard grille lid design; live load rating of H-20 truck loading; lid molded with identifying name and logo as per Standard Details. Manufactured by:
 - 1. Neenah Foundry Company, Product Manholes and Covers.
 - 2. East Jordan Iron Works, Product Manholes and Covers.

3. Or equal.

- B. Manhole Steps: As per Standard Detail Sheets. Formed integral with manhole sections.

2.03 CONFIGURATION

- A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female dry joints; sleeve to receive pipe sections.
- B. Shape: Cylindrical/Rectangular
- C. Clear Inside Dimensions: 48-inch minimum or as indicated on plans.
- D. Design Depth: As indicated on plans.
- E. Clear Lid Opening: As indicated on plans.
- F. Pipe Entry: Provide openings as required.
- G. Steps: As required by Standard Details.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location and ready for roughing into Work.
- C. Verify excavation for manholes is correct in accordance with Section 31 23 16 Excavation.

3.02 PREPARATION

- A. Coordinate placement of inlet and outlet pipe.

3.03 PLACING MANHOLE SECTIONS

- A. Place precast base section, pad, or cast in place pad and level.
- B. Place manhole sections plumb and level.
- C. Grout channel to achieve slope to exit piping. Trowel smooth. Contour as required.
- D. Set cover frames and covers level to correct elevations.
- E. Coordinate with other sections of work to provide correct size, shape, and location.

END OF SECTION

SECTION 33 40 00
STORMWATER UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Site storm sewerage drainage piping, fittings and accessories and bedding.
- B. Connection of building storm water drainage system to municipal sewer utility service.
- C. Catch basins, paved area drainage, site surface drainage, and building drainage.
- D. Replace removed or damaged storm sewers due to construction.

1.02 REFERENCED SECTIONS

- A. Section 01 31 00 - Project Management and Coordination
- B. Section 01 33 00 - Submittal Procedures
- C. Section 01 40 00 - Quality Requirements
- D. Section 01 50 00- Temporary Facilities and Controls
- E. Section 31 05 16 - Aggregates for Earthwork
- F. Section 31 23 16.13 - Trenching

1.03 REFERENCES

- A. American Association of State Highway and Transportation Officials – AASTHO
 - 1. AASHTO - M 36 Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
 - 2. AASHTO - M 252 Corrugated Polyethylene Drainage Pipe
 - 3. AASHTO - M 278 Class PS46 Poly (Vinyl Chloride) (PVC) Pipe
 - 4. AASHTO - M 288 Geotextile Specification for Highway Applications
 - 5. AASHTO - M 294 Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter
- B. ASTM International. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.
 - 1. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
 - 2. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 - 3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³(2,700 kN-m/m³))
 - 4. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
 - 5. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

6. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 7. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
 8. ASTM D2922 - Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
 9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 10. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 11. ASTM D3035 - Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
 12. ASTM D-3350: Standard Specification for Polyethylene Plastics Pipe and Fittings
 13. ASTM F405 Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings
- C. American Water Works Association (AWWA)
1. AWWA C104/A21.4-03: ANSI Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. AWWA C111/A21.11-00: ANSI Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 3. AWWA C151/A21.51-02: ANSI Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water
 4. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 5. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 inch (100 mm) through 63 inch (1,575 mm), for Water Distribution and Trans.
- D. Oakland County Drain Commissioner (O.C.D.C.)

1.04 DEFINITIONS

- A. Bedding: Fill placed under bedside and directly over pipe prior to subsequent backfill operations.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Provide data indicating pipe and pipe accessories.
- C. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the Work of this section.

1.07 FIELD MEASUREMENTS

- A. Verify that field measurements and elevations are as indicated or instructed by the manufacturer.

1.08 COORDINATION

- A. Coordinate work under provisions of Section 01 31 00.
- B. Coordinate the Work with termination of storm sewer connection outside building and connection to municipal sewer utility service.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Reinforced Concrete Pipe:
 - 1. ASTM C76, Class IV or V with Wall Type A; mesh or bar reinforcement; inside nominal diameter indicated. Bell and spigot end joints.
 - 2. Reinforced Concrete Pipe Joint Device: ASTM C443, rubber compression gasket joint.
- B. Smooth Lined Corrugated Polyethylene Pipe (SLCPP)
 - 1. Corrugated polyethylene pipe shall have a smooth interior wall, Manning's "n" of 0.012 or better and shall conform to AASHTO M294.
 - 2. Joints shall be secured with a tied or bolted polyethylene coupler or shall be a factory-made coupler which can be screw turned on to the end corrugations
 - 3. Corrugated polyethylene pipe shall be Advanced Drainage Systems N-12, Hancor HiQ or accepted equal.
- C. Corrugated Steel Pipe:
 - 1. AASHTO M36 Type I; nominal diameter as shown; end joints; helical lock seam; coated inside and out with 0.050-inch-thick bituminous coating.
 - 2. Coupling Bands: Galvanized steel, 0.052 inches thick x 10 inches wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.
- D. Plastic Pipe:
 - 1. ASTM D3034 Type PSM Polyvinyl Chloride (PVC) material, bell and spigot style rubber ring sealed gasket.
- E. Ductile Iron Pipe: AWWA C151.

2.02 PERFORATED UNDERDRAINS

- A. General
 - 1. Underdrain pipe shall be perforated PVC or flexible corrugated plastic or polyethylene pipe.
 - 2. The pipe shall have a factory installed geotextile pipe wrap.
 - 3. Perforation shall meet the requirements of AASHTO M 278.
- B. Polyethylene Pipe (PE): Polyethylene pipe and fittings shall be standard strength and conform to ASTM F 405 and AASHTO M 252.

- C. Polyvinyl Chloride Pipe (PVC): Polyvinyl Chloride pipe and fitting shall be standard strength and conform to ASTM F 949.
- D. Geotextile Pipe Wrap: Geotextile pipe wrap shall weigh at least 3.5 ounces per square yard and shall conform to AASHTO M 288. The minimum tensile strength shall be 100 pounds.

2.03 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.04 CATCH BASINS

- A. See Standard Detail Sheets.

2.05 BEDDING MATERIALS

- A. Bedding: Class II granular fill as specified in Section 31 05 16.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with lean concrete.
- B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.03 BEDDING

- A. Excavate pipe trench in accordance with Section 31 23 16.13 for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches compact depth.
- C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.04 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D2321 and manufacturer's instructions. Seal joints watertight.
- B. Place pipe on minimum 4-inch-deep bed of filter aggregate.
- C. Lay pipe to slope gradients noted on layout drawings with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Install aggregate at sides and over top of pipe. Provide top cover to minimum compacted thickness of 12 inches, compact to 95 percent modified proctor.
- E. Refer to Section 31 23 16.13 for trenching requirements. Do not displace or damage pipe when compacting.

3.05 INSTALLATION OF CATCH BASINS, MANHOLES, AND CLEAN-OUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad with provision for storm sewer pipe and sections.
- C. Level top surface of base pad to receive concrete shaft sections, sleeved to receive storm sewer pipe sections.
- D. Establish elevations and pipe inverts for inlets and outlets as indicated.
- E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.06 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01 40 00.
- B. Request inspection prior to and immediately after placing aggregate cover over pipe.
- C. Compaction testing will be performed in accordance with ASTM D1557.
- D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

3.07 PROTECTION

- A. Protect finished Work under provisions of Section 01 50 00.
- B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 20 05 00 - MECHANICAL GENERAL REQUIREMENTS

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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.
 4. Submit detailed shop drawings of piping systems showing pipe routing and types and locations of all pipe hangers.
 - B. Coordination Drawings:
 1. Submit project specified coordination drawings for review in compliance with Division 01 Specification Sections.
- 1.13 CLOSEOUT SUBMITTALS
- A. 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.
- 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.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 WORK IN EXISTING BUILDINGS

- A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

- B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.
- C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.
- D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement, if necessary, of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.2 TEMPORARY SERVICES

- A. Provide temporary service as described in Division 01.
- B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional cost to the Owner.

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. Domestic Water Booster Systems.
- F. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

3.5 PROJECT COMMISSIONING

- A. Refer to Division 01 "Project Commissioning" and the Commissioning Manual.
- B. Purpose: Training, documentation and verification of the operation and functional performance of mechanical systems for compliance with the "design intent."

END OF SECTION

SECTION 20 05 10 - BASIC MECHANICAL MATERIALS AND METHODS

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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.

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. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
 - 5. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
 - 6. RTRP: Reinforced thermosetting resin (fiberglass) pipe.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. 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. Structural Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. 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.
 - 3. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- G. Solder Filler Metals: ASTM B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.
- H. 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.
- I. 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.
- J. 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.
- K. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
- L. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- M. Solvent Cements for Joining ABS Piping: ASTM D 2235.
- N. Solvent Cements for Joining PVC to ABS Piping Transition: ASTM D 3138.
- O. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

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.

2.5 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.

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

2.7 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.

2.8 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. Existing Piping: Use the following:

- a. Chrome-Plated Piping or Piping in High Humidity Areas: Split-casting, cast-brass type with chrome-plated finish.
- b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
- c. Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.

2.9 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.

2.10 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.

2.11 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. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells in steel pipe. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- G. Brazolets can be used for annular flow measuring devices, temperature control components, and thermal wells in copper tube. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- H. Clean and lubricate elastomer joints prior to assembly.
- I. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.
- J. Install piping to conserve building space and not interfere with use of space.
- K. Group piping whenever practical at common elevations.
- L. 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.
- M. Slope piping and arrange systems to drain at low points.
- N. Slope horizontal piping containing non-condensable gases 1 inch per 100 feet, upward in the direction of the flow.
- O. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- P. 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.
- Q. 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.
- R. Do not penetrate building structural members unless specifically indicated on drawings.
- S. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.
- T. Install valves with stems upright or horizontal, not inverted.
- U. Provide clearance for installation of insulation and access to valves and fittings.
- V. 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.
- W. 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.
- X. Install piping free of sags and bends.

- Y. Install fittings for changes in direction and branch connections.
- Z. 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.
- AA. Install piping to allow application of insulation.
- BB. Select system components with pressure rating equal to or greater than system operating pressure.
- CC. After completion, fill, clean, and treat systems. Refer to Division 23 Sections "Hydronic Piping," "Piping Systems Flushing and Chemical Cleaning," and "HVAC Water Treatment."
- DD. Install escutcheons for penetrations of walls below ceiling, and ceilings.
- EE. Sleeves are not required for core-drilled holes in poured concrete walls.
- FF. Permanent sleeves are not required for holes formed by removable PE sleeves in poured concrete walls.
- GG. 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.
- HH. Existing Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Seal core drilled pipe penetrations using modular mechanical seals. Allow for 1-inch annular clear space between pipe and cored opening 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 cored hole. Assemble modular mechanical seals and install in annular space between pipe and cored opening. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- II. 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.
- 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. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- R. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.
- S. 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.

3.3 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.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

- C. Where pipe and/or equipment support members must be welded to structural building framing, Contractor shall seek prior approval from Architect and structural engineer. Scrape, brush clean, and apply one coat of zinc rich primer after welding.

- D. Field Welding: Comply with AWS D1.1.

3.5 EPOXY BONDING TO EXISTING MATERIALS

- A. Use epoxy bonding compound to set sleeves or pipes in existing concrete to bond new concrete and/or grout to existing materials or to bond dissimilar materials.
- B. The compound, when applied in accordance with the manufacturer's instructions, shall be capable of initial curing within 48 hours at temperatures as low as 40 deg F and shall be capable of bonding any combination of the following properly prepared materials: Wet or dry, cured, or uncured concrete or mortar; vitrified clay; cast iron and carbon steel.

3.6 JACKING OF PIPE

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

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.8 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.

3.9 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.

3.10 FLASHING

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

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

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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 domestic and fire-protection water
- 1.2 DEFINITIONS
 - A. CR: Chlorosulfonated polyethylene synthetic rubber.
 - B. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - C. FPR: Fiberglass reinforced plastic.
- 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.
 - 3. Flowmeters.
 - 4. Thermal-energy meters.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the following to include in operation and maintenance manuals:
 - 1. Flowmeters.
 - 2. Thermal-energy meters.

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 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 PRESSURE GAGES

- A. Manufacturers:
 - 1. AMETEK, Inc.; U.S. Gauge Div.
 - 2. Cambridge.
 - 3. Dwyer Instruments, Inc.
 - 4. Marsh Bellofram.
 - 5. Miljoco Corporation.
 - 6. Terice, 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.

2.3 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 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 chilled- and condenser-water inlets

3.2 INSTALLATIONS

- A. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- B. Install ball valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- C. Install test plugs in tees in piping.

3.3 ADJUSTING

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

END OF SECTION

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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."

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. Trapeze pipe hangers. Include Product Data for components.
 2. Metal framing systems. Include Product Data for components.
 3. Pipe stands. Include Product Data for components.
 4. 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 TRAPEZE PIPE HANGERS

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

2.5 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 1. Anvil; Anvil-Strut; ASC Engineered Solutions.
 2. B-Line by Eaton.
 3. nVent Electrical plc; ERISTRUT Div.
 4. Power-Strut; a part of Atkore International.
 5. Unistrut; a part of Atkore International.
 6. Hilti USA.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- E. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 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.

2.7 FASTENER SYSTEMS

- A. Post-Installed Anchors:
 1. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- a. Manufacturers:
 - 1) B-Line by Eaton.
 - 2) DeWalt Engineered by Powers.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head.
 - 5) MKT Fastening, LLC.
- 2. Internally Threaded Screw Anchors: Internally threaded, self-tapping screw anchor designed for performance in cracked and uncracked concrete. Suitable base materials include normal-weight concrete, sand-lightweight concrete and concrete over steel deck.
 - a. UL Listed or FMG approved for fire sprinkler piping.
 - b. Available Sizes: For 1/4-inch, 3/8-inch, and 1/2-inch diameter rod sizes
 - c. Manufacturers:
 - 1) B-Line by Eaton; Rapid Rod Hangers.
 - 2) DeWalt Engineered by Powers; Snake+.
- 3. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.
 - a. Manufacturers:
 - 1) DeWalt Engineered by Powers.
 - 2) Hilti, Inc.
 - 3) ITW Ramset/Red Head.
 - 4) MKT Fastening, LLC.
 - b. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - c. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - d. Washer and Nut: Zinc-coated steel.
- B. Cast-in-Place Anchors:
 - 1. General
 - a. Threaded Inserts: Galvanized malleable iron or galvanized steel for 3/4 inch bolts.
 - b. Manufacturers:
 - 1) B-Line by Eaton.
 - 2) DeWalt Engineered by Powers.
 - 3) Empire Industries, Inc.

- 4) Hilti, Inc.
 - 5) ITW Ramset/Red Head.
 - 6) MKT Fastening, LLC.
 - 7) Richmond Screw Anchor Co.
2. Slotted Inserts: Continuous galvanized steel with temporary slot fillers and complete with nuts, studs, washers and the like, for 3/4 inch bolts.
- a. Manufacturers:
 - 1) B-Line by Eaton; B22-I Continuous Concrete Insert.
 - 2) Hilti, Inc.; CIS13812/PG.
 - 3) Hohman and Barnard, Inc.
 - 4) Richmond Screw Anchor Co.
 - 5) Unistrut; a part of Atkore International; P-3200 Continuous Insert.

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 hangers and supports with plastic coating, or galvanized metallic coatings for applications in corrosive atmospheres.
- G. Use metal framing, with plastic coating, or galvanized metallic coatings for metal framing in corrosive atmospheres.
- H. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- I. Use padded hangers for piping that is subject to scratching.

- J. 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.
- K. 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.
- L. Concrete Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Anchor Devices, Concrete and Masonry: in accordance with Group I, Group II, Type 2, Class 2, Style 1 and Style 2, Group III and Group VIII or FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry, unless otherwise approved by the Architect. Powder actuated anchoring devices shall not be used to support any mechanical systems components.
 2. Inserts, Concrete: TYPE 18 or 19. When applied to loads equivalent to piping in sizes NPS 2 and larger, and where otherwise required by imposed loads, a one foot length of 1/2 inch reinforcing rod shall be inserted and wired through wing slots. Proprietary type continuous inserts may be proposed and shall be submitted for approval.
 3. Use mechanical-expansion anchors where required in concrete construction.
 4. Use chemical fasteners where required in concrete construction.
- M. 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.
- N. Hanger-Rod Attachments for Wood Construction: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. All Steel Ceiling Plates: UL listed and suitable for attachment to wood beams. For pipe sizes NPS 1/2 to NPS 2. Install in accordance with manufacturer's instructions to maintain listing.

2. Threaded Side Beam Brackets: UL listed and FMG approved, suitable for attachment to wood beams. For pipe sizes NPS 2 to NPS 4. Install in accordance with manufacturer's instructions to maintain listing.
- O. 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.
- P. Comply with MSS SP-58 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-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. Incorporate pipe anchors into piping systems to maintain permanent pipe positions. Install alignment guides for the piping adjacent to and on each side of pipe expansion loops and expansion joints to maintain alignment.
- K. Where necessary, brace piping and supports against reaction, sway and vibration.
- L. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.
- M. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.
- N. 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.
- O. 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.
- P. 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.
- Q. 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.
- R. 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.
- S. 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.

- T. Attach pipe anchors and pipe alignment guides to the building structure where indicated. If not indicated, the method used is optional to the Contractor, subject to approval by the Architect. In the case of structural steel, make attachment by clamping in accordance with the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Building.
- U. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.
- V. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.
- W. 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.
- X. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.
- Y. Building structure shall not be reinforced except as approved by the Architect in writing.
- Z. Use approved cast-in-place inserts or built-in anchors for attachment to concrete structure. Size inserts and anchors for the total applied load with a safety factor in accordance with applicable codes but in no case less than 5. Coordinate installation of all imbedded items in accordance with manufacturer's instructions. Position anchorage and imbedded items as indicated and/or where required and support against displacement during placing of concrete. Cutting or repositioning of concrete beam or girder or reinforcing steel to accommodate inserts will not be allowed. Provide removable closures in imbedded device openings to prevent entry of concrete.
- AA. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.
- BB. Use cast-in-place inserts in concrete beams and girders. Drilled anchors/wedge type inserts shall be used on vertical surfaces only. Coordinate with structural engineer.
- CC. Attach piping supports to the side of concrete beams and concrete joist. Provide supplementary support steel as required. Cast-in-place or drilled anchors will not be permitted in the bottom of concrete beams and concrete joist.
- DD. Attach piping supports to the side of concrete beams or concrete joist. Where intermediate hangers are required to meet the hanger spacing schedule, the Contractor may propose attachment of intermediate pipe supports to the bottom of the concrete slab pending submittal of a satisfactory pull out test. The Contractor shall submit pull out test criteria, pull out test results, proposed hanger detail and hanger point loads to the Architect for written approval.
- EE. Trapeze Pipe Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

- FF. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- GG. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- HH. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- II. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- JJ. 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.
- KK. Install lateral bracing with pipe hangers and supports to prevent swaying.
- LL. 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.
- MM. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- NN. 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.
- OO. Refer to individual piping sections for hanger spacing and hanger rod sizes.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. 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

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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 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. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. 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.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.
- F. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4mil thick, manufactured for direct burial service.
- G. 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.
- 2.3 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.
- 2.4 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 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.

4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, minimum 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- 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 nonconcealed 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 nonaccessible 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.
- 3.3 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.
- 3.4 VALVE-SCHEDULE INSTALLATION
- A. Mount valve schedule on wall in accessible location in each major equipment room.
- 3.5 ADJUSTING
- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.
- 3.6 CLEANING
- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

3.7 SCHEDULES

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

PIPE LABELING AND COLOR CODING

<u>Pipe System Label</u>	<u>Drawing Abbrev.</u>	<u>Labels</u>	<u>Piping</u>
Domestic Cold Water	CW	White on Green	Light Green

PIPE LABELING AND COLOR CODING

<u>Pipe System Label</u>	<u>Drawing Abbrev.</u>	<u>Labels</u>	<u>Pipe Color</u>
Domestic Cold Water	CW	Black on Green	Dark Blue

END OF SECTION

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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.

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. PSK: Polypropylene, scrim, kraft paper.
- D. PVC: Polyvinyl Chloride.
- E. 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 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.

1.6 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.

1.7 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.

1.8 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.

1.9 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 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.; Aero seal and Aero seal 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.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Childers Products, H.B. Fuller Company; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. Johns Manville Industrial Insulation; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

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

1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Childers Products, H.B. Fuller Company; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. Johns Manville Industrial Insulation; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.5 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.

2.6 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. Metal Jacket:
- 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. PABCO-Childers Metals; Johns Manville Industrial Insulation; Metal Jacketing Systems.
 - b. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

- 2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.
- 3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.7 TAPES

- A. 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.
- B. 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.

2.8 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.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
 - 2) GEMCO; Press and Peel.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the products specified.
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- 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.

2.9 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

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, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at 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 Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations 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."

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 AND MINERAL WOOL 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 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 metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

- D. Where self-adhesive jackets are indicated, install according to manufacturer's instructions and details on the drawings. Overlap seams arranged to shed water.
- E. Where sound barrier jackets are indicated, install in accordance with manufacturer's instructions.

3.9 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

END OF SECTION

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING

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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 22 Piping Sections for specialty valves applicable to those Sections only.

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.
- 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 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
 - 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 irrigation systems.
 - G. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
 - H. Valve Actuators:
 - 1. 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, Full-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; 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 77CLF-A Series.
 - b. Hammond Valve.
 - c. Kitz Corporation; Kitz Valves.
 - d. Milwaukee Valve Company; UPBA400S/450S.
 - e. NIBCO INC.; Models S-585-70-66-LF/T-585-70-66-LF.

- f. Watts Water Technologies, Inc.; Series LFB6080G2/LFB6081G2.

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.
- 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.

2.4 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.

2.5 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.

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

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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 and water meters inside the building.
- B. Water meter will be furnished and installed by the mechanical/plumbing contractor.

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. 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 and water meters.

1.6 CLOSEOUT SUBMITTALS

- A. Field quality-control test reports.
- B. Water Samples: Specified in Part 3 "Cleaning" Article.

1.7 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.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not proceed with interruption of water service without Construction Manager's and Owner's written permission.

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. 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.
- B. 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.

2.4 VALVES

- A. General-duty plumbing valves; and drain valves are specified in Division 22 Section "Plumbing Valves."

2.5 WATER METERS

- A. Refer to Division 20 Section "Mechanical General Requirements."
- B. Compound-Type Water Meters: AWWA C702, totalization meter with integral main-line and bypass meters, bronze case, and 150-psig minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with flanged end connections.
 - 1. Manufacturers:
 - a. Badger Meter, Inc.
 - b. Sensus Metering Systems Inc.

- c. Kent/AMCO.

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSTALLATION

- A. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- B. Install 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."
- C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- D. 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."
- E. 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.
- F. 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.
- G. Install domestic water piping level without pitch and plumb.

3.2 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.3 WATER METER INSTALLATION

- A. Water meters will be furnished and installed by the mechanical/plumbing contractor.
- B. Rough-in domestic water piping for water meter installation and install water meters according to utility company's requirements.
- C. Install water meters according to AWWA M6 and utility's requirements.
 - 1. Install compound-type water meters with shutoff valves on water-meter inlet and outlet. Support meters, valves, and piping on brick or concrete piers.

3.4 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 2-1/2: 108 inches with 1/2-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- 3.5 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. Booster Pumps: Cold-water suction and discharge piping.
- 3.6 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.

3.7 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. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
5. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.8 CLEANING AND DISINFECTION

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

B. Clean and disinfect potable and non-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

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

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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.	
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 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: 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.

2.2 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 2-1/2 to NPS 4: 0.045 inch.
8. Drain: Pipe plug.

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.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping and specialties.

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. Reduced-pressure-principle backflow preventers.
- 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

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

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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. 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 SYSTEMS DESCRIPTIONS

- A. Sanitary waste and vent piping system materials are scheduled on the Drawing.

1.4 ACTION SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.5 CLOSEOUT SUBMITTALS

- A. Field quality-control inspection and test reports.

1.6 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 COPPER TUBE AND 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.

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

3.3 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. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.4 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section "Mechanical Identification."

3.5 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.

3.6 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

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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.
- B. Mechanical and Electrical Specifications have been developed utilizing Construction Specifications Institute MasterFormat and make use of the Facilities Services Subgroup - Divisions 20-28; Site and Infrastructure Subgroup - Division 33; and Process Equipment Subgroup - Divisions 40 and 42.
- C. Division 1 Documents and Architectural Specifications in Divisions 2 through 14 have been developed in the MasterFormat 95 Edition and utilize Division 1 through Division 14.

- D. Where Division 15 Mechanical or Division 16 Electrical are referenced in Division 1 Documents, or within the Architectural Specifications in Divisions 2 through 14, they should refer to Division 20-28, 33, 40, and 42. For additional cross reference information refer to the Construction Specifications Institute.

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. 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. Provide detailed layout shop Drawings on electronic media of all lighting and power distribution systems, routing of conduits, combining of circuits, circuiting, details, and

related information necessary for installation and maintenance. After review by the Architect/Engineer, electronic Drawings will be stamped and returned to the Contractor.

- D. 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 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.

1.15 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.

1.16 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 DEMOLITION WORK

- A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items related to the existing systems that are being removed such as, but not limited to, electrical equipment, cabinets, devices, lighting fixtures, conduit, fittings, boxes, wiring, and supports. No abandoned components of the electrical systems indicated to be removed shall remain.
 - 1. Where electrically powered equipment is included in the demolition scope of other trades, disconnect electrical wiring connections and remove circuit wiring complete.
- B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.
- C. Unless specifically noted otherwise, removed materials shall not be reused in the work.
 - 1. Materials indicated to be salvaged shall be carefully removed, stored, and protected from damage.
 - 2. Salvaged materials intended to be re-used shall be thoroughly cleaned, refurbished if necessary, and determined to be fully functional prior to placing back into service.
 - 3. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items that the Owner has waived ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.
- D. Where equipment or fixtures are removed, outlet boxes that remain recessed in walls shall be properly blanked off, and conduits capped. After alterations are complete, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical systems remaining in service shall not be changed unless specifically indicated as part of the project scope.

3.3 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.

3.4 WORK IN EXISTING BUILDINGS

- A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption to return work areas as soon as possible to Owner.
- B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.
- C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.
- D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal, or other work that is related in any way whatsoever to hazardous materials under the Contract.

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.

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", 1-1/2" EMT conduit; #12, #10, #8, #6, #2 building wire; duplex receptacles, GFCI receptacles, data box and raceway, 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

SECTION 26 05 19 - CONDUCTORS AND CABLES

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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 ACTION SUBMITTALS
 - A. Submit letter of compliance (intent) for copper and aluminum building wire.
- 1.4 INFORMATIONAL SUBMITTALS
 - A. Field Quality-Control Test Reports.
- 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.

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.

2.2 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. Feeders and Branch Circuits: Solid or stranded for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- C. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).
- D. Use conductor not smaller than 14 AWG for 120V control circuits.
- E. 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. Connection between Variable Frequency Controllers and Motors: Use power cable for variable frequency- controlled motors. Install and terminate according to cable manufacturer's recommendations.
- D. Isolated Power System Circuits: Use Type XLP in raceway.

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 26 05 33 "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. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- H. Provide a separate neutral conductor for each circuit unless multi-wire branch circuits are specifically indicated on the drawings.
- I. 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.
- J. Cable shall be supported and secured at intervals not exceeding 4'-0" in new construction.
- K. AC/MC cable shall not be used.
- 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.

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.
- 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.
- 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 Sta-Kon connectors to terminate stranded conductors #10 AWG and smaller to screw terminals.
- H. 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.
- I. Provide lugs suitable for bussing and conductor material used.

- J. Use appropriately sized compression pin adapters to make terminations at equipment where equipment lugs cannot accommodate conductors that are oversized for voltage drop or similar conditions.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

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 26 05 33 "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

SECTION 26 05 26 - GROUNDING AND BONDING

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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 837: Qualifying Permanent Connections Used in Substation Grounding.
- H. IEEE 1100 – 1992: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.
- I. IEEE C2: National Electrical Safety Code.

- J. NETA MTS – 2001: Maintenance Testing Specifications.
- K. NFPA 70: National Electrical Code.
- L. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.
- M. NFPA 99: Health Care Facilities.
- N. NFPA 780: Lightning Protection Code.
- O. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.
- P. UL 96: Lightning Protection Components.
- Q. UL 467: Grounding and Bonding Equipment.
- R. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- S. UL 486B: Wire Connectors for Use with Aluminum Conductors.

1.4 INFORMATIONAL SUBMITTALS

- A. Field Quality Control 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 CLOSEOUT SUBMITTALS

- A. Project Record Documents
 - 1. Submit under provisions of Division 26 “Electrical General Requirements”.
 - 2. Accurately record actual locations of grounding electrodes and connections to building steel.

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. Comply with UL 467.
- B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- D. Comply with ANSI/TIA/EIA-607 “Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications”.
- E. Comply with ANSI/IEEE 1100 -1992 “Powering and Grounding Sensitive Electronic Equipment”.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.

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. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.
 - 1. Where existing branch circuits are using conduit as equipment grounding conductor and are extended, provide grounding bushing on existing conduit and provide new equipment grounding conductor with new branch circuit.
- E. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.
- F. grounding conductor with supply branch-circuit conductors. Bond pole and foundation reinforcing steel to equipment ground conductor.
- G. Verify specific equipment grounding requirements with the manufacturer's recommendations.

3.2 INSTALLATION

- A. 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.

3.3 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

SECTION 26 05 33 - RACEWAYS AND BOXES

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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 ACTION 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.
- C. All work in natatoriums, pool areas and fountain structures shall be in accordance with N.E.C. article 680, "Swimming Pools, Fountains, and Similar Installations."

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. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.

- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- F. EMT: ANSI C80.3.
- G. FMC: Zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. 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 type.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 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.

2.3 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. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

2.4 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 open 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.

2.5 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."

2.6 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: Carbon steel. Include two for each sealing element.
 - 3. 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.

2.7 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.

2.8 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, 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. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- H. Do not install aluminum conduits in contact with concrete.
- I. Install surface raceways only where indicated on Drawings.
- J. 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 EMT 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. Provide pull string and 25% spare capacity in every branch circuit conduit.
- V. 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 conduit (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.
- W. 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.
- X. 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.
- Y. 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 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: 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.
- Z. Flexible Conduit Connections: Comply with NEMA RV3. Use maximum of 72 inches of flexible conduit for recessed and semirecessed 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.
- AA. 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.

- BB. 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.
- CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- DD. Locate boxes so that cover or plate will not span different building finishes.
- EE. 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.
- FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- GG. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- HH. Do not route feeders across roof.
- 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. Ferrous metal conduit in natatorium/pool environments shall use compression or threaded fittings. Conduit, fittings, boxes, and supports shall be treated with corrosion resistant paint specified in Division 9.
- KK. Route conduits in finished areas with exposed ceilings at underside of structural deck or as high as possible.
- LL. 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

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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 and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Equipment identification labels.
 - 5. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 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 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.

2.5 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.

2.6 WIRING DEVICE IDENTIFICATION

- A. Description: Self adhesive label with black upper case letters on clear polyester label, font size 7.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.
- B. 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.
- C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
 - 1. Telecommunication System: Green and yellow.
 - 2. Control Wiring: Green and red.
- D. 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.
- E. 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.
- F. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.
- G. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.
- H. 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.
- I. 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.
- J. 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.
- K. 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. Transformers.
 - c. Disconnect switches.
 - d. Contactors.
- L. Wiring Device Identification Labels: On each faceplate install circuit designation label that is consistent with panelboard directories, and as-built plan drawings. Apply labels to receptacle faceplates centered below bottom outlet. Apply labels to toggle switch faceplates on backside.

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
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- 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

SECTION 26 05 73 - OVERCURRENT DEVICE COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

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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 ACTION SUBMITTALS
- 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 INFORMATIONAL SUBMITTALS
- 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.
- E. The data files native to the software used to complete the study shall be provided to the owner.

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

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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. 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 "Dimming Controls" for architectural dimming system equipment.
 - 4. 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 INFORMATIONAL SUBMITTALS
- A. Field quality-control test reports.
- 1.5 CLOSEOUT SUBMITTALS
- A. 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 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, per NEMA ICS2, with 120 volt, 60 hertz coil and 600 volt, 60 hertz, 30 ampere three pole contacts with size and number of poles indicated.
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 NEMA type 1 hinged cover cabinet enclosure sized as required for contactors as indicated on drawings. Mount switches and indicating lights required on front of enclosure. Install terminal strips for connection of all external control wiring connections.
5. Provide solderless pressure wire terminals.
6. Provide corrosion-resistant primer treatment with light gray baked acrylic enamel finish.
7. 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 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.

3.3 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.

3.4 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.

3.5 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

SECTION 26 09 99 - ELECTRICAL TESTING

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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 "Enclosed Switches."
 - 4. Division 26 Section "Panelboards."
 - 5. 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. The Contractor shall be familiar with the work required by the testing firm, fully cooperate with implementation of the acceptance testing program, and provide any work in this section specifically required by the Contractor. Perform all tests and inspections as specified herein. All references made to "testing firm" shall apply to the work of the Contractor.
- 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 corporately independent and 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 onsite 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 Contractor shall submit proof of the above qualifications with bid proposal.
- F. The terms test agency, test contractor, testing laboratory, test organization, or contractor test company, shall be construed to mean the testing firm.
- G. Acceptable Testing Firms:
 - 1. Potomac 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 firm 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 firm 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 (NOT APPLICABLE)

END OF SECTION

SECTION 26 22 00 - DRY-TYPE TRANSFORMERS (600 V AND LESS)

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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 types of dry-type transformers rated 600 V and less, with capacities up to 750 kVA:
 - 1. Distribution transformers.
 - 2. Control and signal transformers.
- B. Related Section includes the following:
 - 1. Division 26 Section "Electrical General Requirements."
 - 2. Division 26 Section "Grounding and Bonding."
 - 3. Division 26 Section "Conductors and Cables."
 - 4. Division 26 Section "Raceways and Boxes."
 - 5. Division 26 "Hangers and Supports for Electrical Systems" for concrete bases.

1.3 REFERENCES

- A. ANSI/IEEE C57.12.9: Test Code for Dry-Type Distribution and Power Transformers
- B. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. NEMA ST 1: Specialty Transformers
- D. NEMA ST 20: Dry Type Transformers for General Applications

- E. NEMA TP 1: Guide for Determining Energy Efficiency for Distribution Transformers
- F. NEMA TP 2: Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- G. NETA ATS: Acceptable Testing Specifications for Electrical Power Distribution Equipment and Systems
- H. NFPA 70: National Electrical Code
- I. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors
- J. UL 486B: Wire Connectors for Use with Aluminum Conductors
- K. UL 506: Specialty Transformers
- L. UL 1561: Dry-Type General Purpose and Power Transformers

1.4 ACTION SUBMITTALS

- A. Product Data Include rated nameplate data, capacities, weights, dimensions, utility or manufacturer's anchorage and base recommendations, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
 - 1. Transformer Inrush: Provide time-current coordination curves demonstrating transformer inrush and ANSI damage curves with primary overcurrent device selections to clear inrush yet still protecting damage curve.
- B. Shop Drawings: Wiring and connection diagrams.

1.5 INFORMATIONAL SUBMITTALS

- A. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Source quality-control test reports. Include loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
- E. Field quality control test reports
- F. Output Settings Reports: Record of tap adjustments specified in Part 3.

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 IEEE C 57.12.91.
- C. Comply with NFPA 70.

- D. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting 2016 efficiency levels when tested according to NEMA TP2.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- B. Store, protect, and handle products to site under provisions of Division 26 section "Electrical General Requirements."
- C. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- D. Accept transformers on site. Inspect for damage.
- E. 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.
- F. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 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."
- B. Coordinate installation of wall-mounting and structure-hanging supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme.
 - 2. Eaton
 - 3. ABB
 - 4. Siemens Industries, Inc.
 - 5. [Square D/Groupe Schneider NA.](#)
 - 6. [Sola/Hevi-Duty Electric.](#)

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and tested, air-cooled units for 60 Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

- C. Transformers Rated 15 kVA and Larger:
 - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 - 2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.
 - 2. Grounded to enclosure.
- C. Coils: Continuous windings without splices, except for taps.
 - 1. Coil Material: Copper.
 - 2. Internal Coil Connections: Brazed or pressure type.
- D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.
- E. Enclosures: Ventilated
 - 1. Core and coil must be encapsulated within resin compound to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 - 3. Vibration Isolation: Isolate core and coil from enclosure using vibration-absorbing mounts.
 - 4. Wiring Compartment: Sized for conduit entry and wiring installation.
 - 5. Environmental Protection:
 - a. Indoor: UL 50E, Type 2.
 - b. Outdoor: UL 50E, Type 3R.
 - 6. Finish Color: Gray weather-resistant enamel.
- F. Provide transformers that are internally braced to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems".
- G. Taps for Transformers 3 kVA and Smaller: None.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

- K. Basic Impulse Level: 10 kV.
- L. Mounting: Suitable for mounting as indicated.
- M. Wall Brackets: Manufacturer's standard brackets.
- N. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.
- O. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests and Inspections: Provide the factory tests on the actual transformers provided or on similar units identical to those provided. Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of certification of system compliance on control units.
 - 1. Resistance measurements of windings at rated voltage connections and at tap connections.
 - 2. Ratio tests at rated voltage connections and at tap connections.
 - 3. Phase relation and polarity tests at rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation-Resistance Tests:
 - a. Line-side to ground.
 - b. Load-side to ground.
 - c. Line-side to load-side.
 - 9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls and floors for suitable mounting conditions where transformers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
 - 2. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Install floor mounted transformers on and anchor to concrete bases according to manufacturer's recommendations.
 - 1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- D. Install floor mounted transformers on and anchor to concrete bases according to manufacturer's recommendations, seismic codes at Project, and requirements in Division 26 section "Vibration and Seismic Controls for Electrical Systems."
 - 1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- E. Identification: Engraved metal or laminated-plastic nameplate mounted with corrosion resistant screws. Provide nameplate according to Division 26 Section "Electrical Identification" indicating the following:
 - 1. Transformer designation (e.g. "T-1").
 - 2. Primary power characteristics (e.g. "480V, 3PH, 3W").
 - 3. Secondary power characteristics (e.g. "208Y/120V, 3PH, 4W").
 - 4. Power rating (e.g. "75 kVA").
 - 5. Power source (e.g. "Fed from DP-1).

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. Provide conduit according to Division 26 Section "Raceways and Boxes" for connections to transformer case. Make conduit connections to side panel of enclosure.
- D. 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.
- E. Check for damage and tighten connections prior to energizing transformer.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing" for transformers 75KVA and above:

1. Visual and Mechanical Inspection
 - a. Inspect for physical damage, cracked insulators, tightness of connections, defective wiring and general mechanical and electrical conditions.
 - b. Verify proper core grounding.
 - c. Verify proper equipment grounding.
 - d. Compare equipment nameplate with single line diagram and report discrepancies.
2. Electrical Tests
 - a. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistance values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
 - b. Perform a turns ratio test between windings at every tap position. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
 - c. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
 - d. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
3. Test Values
 - a. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.
 - b. The polarization index should be above 1.2 unless an extremely high value is obtained initially, such that when doubled will not yield a meaningful value.
 - c. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.
- B. Adjust buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report that records output voltages and tap settings.

END OF SECTION

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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 ACTION 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. 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.

1.6 CLOSEOUT SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- B. 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.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source 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 NEMA PB 1.
- D. Comply with NFPA 70.

1.8 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.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner's representative no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without written permission from Owner's representative.

1.9 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.

1.10 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. 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.
 - b. ABB.
 - c. [Siemens Industries, Inc.](#)
 - d. Square D by Schneider Electric

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

- B. 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. ABB – 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, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - 3. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

- C. 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.
 - 3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box as called out on panel schedules.

- D. Conductor Connectors: Suitable for use with conductor material.
 - 1. Main and Neutral Lugs: Mechanical type.
 - 2. Ground Lugs and Bus Configured Terminators: Compression type.
 - 3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 4. Double Lugs: Mechanical type mounted at location of main incoming lugs.

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.
- 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.
 - 3. Fused switches.

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. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
- 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. Do not use tandem circuit breakers.
 4. Provide lock on devices for circuit breakers when called out on panel schedules with "LOD" designation.
 5. Provide GFCI circuit breaker when called out on panel schedules with "GFCI" designation.
- C. Circuit Breaker Selection for Transformer Primary Protection:
1. 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.
- 2.7 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 Owner's representative.
- 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.

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

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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. Device wall plates.
- 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 ACTION SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations for each type of product indicated.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality control test reports

1.7 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.

1.8 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 GENERAL WIRING DEVICE REQUIREMENTS

- A. Comply with NFPA 70, NEMA WD 1, NEMA WD 6, and UL498.
- B. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- C. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Brown, unless otherwise indicated or required by NFPA 70 or device listing.

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 Wire Device-Kellems: 5352
 - b. Eaton/Arrow Hart Wiring Devices: 5362
 - c. Leviton: 5362
 - d. Legrand, Pass & Seymour: 5362
- B. 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

2.3 INDUSTRIAL-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: HBL 5362
 - b. Eaton/Arrow Hart Wiring Devices: AH5362
 - c. Leviton: 5362
 - d. Legrand, Pass & Seymour: 5362A
- B. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.

2.4 USB RECEPTACLES

- A. Tamper-Resistant Duplex NEMA 5-20R and USB Charging Receptacle:
 - 1. Decorator style.

2. Comply with UL 1310.
3. USB Charging 3.0A (minimum), 5VDC dual ports.
 - a. Comply with battery charging specification USB BC1.2
 - b. Compatible with USB 1.1/2.0/3.0 devices, including Apple products.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Wiring Device: USB20X2-x
 - b. Eaton/Arrow Hart Wiring Devices: TR7756-x
 - c. Leviton: T5632
 - d. Legrand, Pass & Seymour: TR5362USB Full Duplex and USB

B. USB Charging Receptacle:

1. Decorator style.
2. Comply with UL 1310.
3. USB Charging 4.0A (minimum), 5VDC four-ports.
 - a. Comply with battery charging specification USB BC1.2
 - b. Compatible with USB 1.1/2.0/3.0 devices, including Apple products.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Wiring Device: USB4
 - b. Eaton/Arrow Hart Wiring Devices: 7750
 - c. Leviton: USB4P

2.5 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. Weather-Resistant Duplex GFCI Receptacle, NEMA 5-20R:

1. Manufacturers: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell Wiring Device-Kellems: GFWRST20
 - b. Eaton/Arrow Hart Wiring Devices WRSGF20

- c. Leviton: GFWR2
 - d. Legrand, Pass & Seymour: 2097TRWR
- D. 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
- 2.6 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
- 2.7 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 Non-Metallic with hinged cover and listed and labeled as Extra Duty Weatherproof While-In-Use.
 - a. Manufacturers:
 - 1) Hubbell: MM420
 - 2) Legrand, Pass & Seymour: WIUC10FRED
 - 3) Eaton/Arrow Hart: WIU-1VX
 - 4) Red Dot: CKPS
 - 5) Intermatic: WP5000

5. Material for Wet Locations: Recessed Non-Metallic with hinged cover and listed and labeled as Extra Duty Weatherproof While-In-Use.
 - a. Coordinate cover type with exterior wall material.
 - b. Manufacturers:
 - 1) Arlington In Box: DB Series
6. 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
7. 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, including pool environments.
 - 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, exam rooms, pediatric patient rooms, 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. Coordinate installation of access floor boxes with access floor system provided by Architectural trades.
 - O. Install properly oriented access floor boxes into cutouts in access floor tiles and secure to tiles per Manufacturer's instructions.
 - P. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
 - Q. 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 face 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

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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.

1.3 ACTION 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. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 1 Section "Closeout Procedures," 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.

1.5 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.

1.6 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.

1.7 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse 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. Other Branch Circuits: Class RK1, time delay.

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

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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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".
 - 2. Division 26 Section "Hangers and Supports for Electrical Systems".

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers.
 - 5. Molded-case switches.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault circuit-interrupter for equipment protection.
- D. GFLS: Ground-fault circuit-interrupter for life safety.
- E. HD: Heavy duty.
- F. RMS: Root mean square.
- G. 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. NEMA PB2.1: General Instructions for Proper Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
- I. NFPA 70: National Electrical Code.
- J. UL 50: Enclosures for Electrical Equipment, Non-Environmental Considerations.
- K. UL 50E: Enclosures for Electrical Equipment, Environmental Considerations
- L. UL 98: Enclosed and Dead-Front Switches
- M. UL 489: Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
- N. UL 1053: Standard For Ground-Fault Sensing and Relaying Equipment.
- O. UL 1077: Supplementary Protectors for Use in Electrical Equipment
- P. UL 508: Industrial Control Equipment

1.5 ACTION SUBMITTALS

- A. Product Data:
 - 1. 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.
 - 2. Enclosure types and details for types other than UL 50E, Type 1.

3. Current and voltage ratings.
 4. Short-circuit current rating.
 5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers.
1. Include plans, elevations, sections, details, and attachments to other work.
 2. Include wiring diagrams for power, signal, and control wiring.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. 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.
- 1.7 CLOSEOUT SUBMITTALS
- A. 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 Section "Closeout Procedures," 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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2.2 FUSIBLE SWITCHES

- A. Manufacturers:
 - 1. Eaton.
 - 2. ABB.
 - 3. Siemens Industries, Inc.
 - 4. Square D by Schneider Electric.
- B. Type GD, General Duty, Three Pole, Single Throw, 240 V(ac), 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Service-Rated Switches: Labeled for use as service equipment.
 - 5. Hook stick Handle: Allows use of hook stick to operate handle.
 - 6. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120 V(ac).
 - a. Provide auxiliary contacts for fusible switches serving Elevators.
 - 7. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

- A. Manufacturers:
 - 1. Eaton.
 - 2. ABB.

3. Siemens Industries, Inc.
4. Square D by Schneider Electric.
- B. Type GD, General Duty, Three Pole, Single Throw, 240 V(ac), 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Three Pole, Double Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating – 120VAC.
 - a. Provide auxiliary contacts for motor disconnects served by variable frequency controllers.
 4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish:
 1. Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1).
 2. Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (UL 50E Types 3R, 12).
 3. A brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel)
 4. Copper-free cast aluminum alloy (UL 50E Types 7, 9).
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both end walls.
- D. Operating Mechanism:
 1. Directly operable through front cover of enclosure (UL 50E Type 1).
 2. Directly operable through dead front trim of enclosure (UL 50E Type 3R).
 3. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position

once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

- E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
- F. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

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 SELECTION OF ENCLOSURES

- A. Indoor, Dry and Clean Locations: UL 50E, Type 1.
- B. Outdoor Locations: UL 50E, Type 3R.
- C. Other Wet or Damp, Indoor Locations: UL 50E, Type 4.
- D. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:
 - 1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - 2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
 - 3. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 - 4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
 - 5. Install fuses in fusible devices.
- C. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- D. Anchor floor-mounted switches to concrete base.
- E. Install switches with off position down.
- F. Install NEMA KS 1 enclosed switch for motor loads ½ HP and larger and equipment loads greater than 30A.

- G. Install toggle disconnect switch, surface mounted, for motor loads less than ½ HP and equipment loads 30A. and less.
- H. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.
- I. Install equipment on exterior foundation walls at least one inch from wall to permit vertical flow of air behind breaker and switch enclosures.
- J. Support enclosures independent of connecting conduit or raceway system.
- K. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.
 - 3. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

3.5 FIELD QUALITY CONTROL

- A. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. 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.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- C. Perform field quality control tests in accordance with Division 26 section "Electrical Testing":
- D. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the following methods:

- 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - b. Measure contact resistance across each switchblade fuse holder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."
- E. Tests and Inspections for Molded-Case Circuit Breakers:
1. Visual and Mechanical Inspection:
 - a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.

- d. Verify that unit is clean.
 - e. Operate circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with coordination study.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 M Ω .
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

- 2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.
- f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Test and adjust controls, remote monitoring, and safeties.
- F. Nonconforming Work:
1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 2. Remove and replace defective units and retest.
- G. Collect, assemble, and submit test and inspection reports.
1. Test procedures used.
 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 3. List deficiencies detected, remedial action taken, and observations after remedial action.
- H. Manufacturer Services:
1. Engage factory-authorized service representative to support field tests and inspections.
- 3.6 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
 - B. Set field-adjustable circuit-breaker trip ranges in accordance with study report specified in Division 26 Section "Overcurrent Device Coordination Study/Arc Flash Hazard Analysis".

3.7 PROTECTION

- A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

- A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
 - 1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
 - 3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
 - 4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

3.9 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip and time delay settings to values as determined by the protective device coordination study.

3.10 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

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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. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.
- D. 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 ACTION 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. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. 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. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 - 3. Wiring Diagrams: Power wiring.

- C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.

1.6 INFORMATIONAL SUBMITTALS

- A. 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.
- B. Qualification Data: For agencies providing photometric data for lighting fixtures.
- C. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
- B. Warranty: Special warranty specified in this Section.

1.8 MAINTENANCE MATERIALS SUBMITTALS

- A. Spare parts
- B. Extra stock material

1.9 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. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- 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 IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

1.10 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. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.11 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.

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 Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Architect's sample of manufacturer's standard color.
 - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: As indicated in the Luminaire cut sheet.

2.3 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."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.
- 2.4 ALUMINUM POLES
- A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
1. Shape: Round, straight.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 2. Finish: Same as pole.
- F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: As noted in the Luminaire Data sheets.

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.
 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- D. Adjust luminaires that require field adjustment or aiming.

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.
- 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. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 3. Install base covers, unless otherwise indicated.
 4. 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. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
1. Dig holes large enough to permit use of tampers in the full depth of hole.
 2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
1. Make holes 6 inches in diameter larger than pole diameter.
 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. 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.
- H. Raise and set poles using web fabric slings (not chain or cable).
- 3.3 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.
- 3.4 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."

3.5 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. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
 - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. 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.

3.6 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



FEATURES & SPECIFICATIONS

INTENDED USE — These specifications are for USA standards only. Round Straight Aluminum is a general purpose light pole for up to 30-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 one-piece extruded 6063 aluminum alloy with T6 temper. The shaft is uniform in cross-section down length of pole with no taper. Available shaft diameters are 4", 4.5" 5", and 6".

Pole Top: Options include 4" tall 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 non-reinforced handhole with grounding provision is provided near the base. Standard positioning varies with shaft width as follows: 4", 4.5", and 5" shaft, handhole at 12"; 6" 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. All handholes for a pole specified with openings for 4" through 6" shaft width has nominal dimension of 2" x 4" with surface mount overlap design. Standard and extra handholes come with cover and attachment hardware.

Bolt Caps/Base Cover: Pole base plate utilizes cast aluminum A365 bolt caps to cover anchor bolt and nut assembly. 1 piece, spun aluminum base cover available as an option.

Anchor Base/Bolts: Anchor base is cast from A356 alloy aluminum and is heat treated to a T6 temper after welding. 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. Each hot-dipped galvanized anchor bolt is furnished with two hex nuts and two flat washers.

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 SA and SB 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. Factory-applied primer paint finish is available for customer field-paint applications.

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.

APPROVED ALTERNATE MANUFACTURERS:
1. HAPCO RSA
2. VALMONT RNTA

Type

16'-4" POLE

Anchor Base Poles

RSA

ROUND STRAIGHT ALUMINUM



OUTDOOR

POLE-RSA

RSA Round Straight Aluminum Poles

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: RSA 16 4-5C T20 BA

RSA						
Series	Nominal fixture mounting height	Nominal shaft base size/wall thickness ¹	Mounting ²	Options		Finish
RSA	8'-30' (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.) 16-4	4C 4" (.125") 4-5C 4 1/2" (.125") 4-5G 4 1/2" (.188") 5C 5" (.125") 5E 5" (.156") 5G 5" (.188") 6E 6" (.156") 6G 6" (.188") (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) T35 4" O.D. (3-1/2" NPS) <u>DSX/RX/OMERO™ Drill mounting³</u> DM19AS 1 at 90° DM28AS 2 at 180° DM28AS PL 2 at 180° with one side plugged DM29AS 2 at 90° DM32AS 3 at 120° DM39AS 3 at 90° DM49AS 4 at 90° <u>RAD Drill mounting³</u> DM19RAD 1 at 90° DM28RAD 2 at 180° DM29RAD 2 at 90° DM32RAD 3 at 120° DM39RAD 3 at 90° DM49RAD 4 at 90° <u>ESX Drill mounting³</u> DM19ESX 1 at 90° DM28ESX 2 at 180° DM29ESX 2 at 90° DM39ESX 3 at 90° DM49ESX 4 at 90° <u>Arm Drill mounting</u> To be added as series + drill orientations Ex: SMAC19 for SMAC arm drilling 1 at 90°	L/AB Less anchor bolts (Include when anchor bolts are not needed) VD Vibration damper ⁴ TP Tamper resistant handhole cover fasteners JHxy J-Hook for cable strain relief ⁵ HAXy Horizontal arm bracket (1 fixture) ^{5,6} FDLxy Festoon outlet less electrical ^{5,7} FDLGFCIxy Festoon with GFCI outlet and in-use cover ^{5,8} CPL12/xy 1/2" I.D. coupling ⁵ CPL34/xy 3/4" I.D. coupling ⁵ CPL1/xy 1" I.D. coupling ⁵ NPL12/xy 1/2" O.D. threaded nipple ⁵ NPL34/xy 3/4" O.D. threaded nipple ⁵ NPL1/xy 1" O.D. threaded nipple ⁵ EHHxy Extra handhole ^{5,9} 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) VM Match pole to prior order or project ¹¹	<u>Super durable paint colors</u> DDBXD Dark bronze DBLXD Black DNAXD Natural aluminum DWHXD White DDBTXD Textured dark bronze DBLBXD Textured black DNATXD Textured natural aluminum DWHGXD Textured white <u>Brushed finish</u> BA Brushed aluminum <u>Class 1 architectural anodized</u> ABL Black ADB Dark bronze ANA Natural <u>Architectural colors and special finishes¹²</u> VP33A 3 year warranty extension VP55A 5 year warranty extension RAL#### Use designated Lithonia Lighting nomenclature in <u>brochure</u> Custom color Nomenclature assigned through Customer Care "Custom Color Process"	

Accessories: Order as separate catalog number.	
PL DT20	Plugs for ESX drillings
PL DT8	Plugs for DMxAS drillings

NOTES:

- Wall thickness will be signified with a "C", "E" or a "G" in nomenclature. "C" - 0.125 | "E" - 0.156 | "G" - 0.188.
- PT open top poles include top cap. When ordering tenon mounting and drill mounting for the same pole, specify as drilling option/tenon option. The combination includes a required extra handhole.
Example: DM28/T20.
- Refer to the fixture spec sheet for the correct drilling template pattern and orientation compatibility.
- On 4", 4.5" and 5" poles, VD cannot be installed if provisions (EHH, FDL, NPL, CPL) are located higher than 2/3 of the pole's total height.
Example: Pole height is 25ft. A provision cannot be placed above 16ft.
- Specify location and orientation when ordering option.
For "x": Specify the height above the base of pole in feet and inches; separate feet and inches with a "-".
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
- 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 HAXxy.
Example: HA20BD.
- FDL does not come with GFCI outlet or handhole cover. These must be supplied by contractor or electrician.
- Festoon option that comes with GFCI and weather tight, steel, in-use cover. GFCI and in-use cover ship separately from pole.
- Combination of tenon-top and drill mount includes extra handhole. EHH includes cover.
- Use when mill certifications are required. Some configurations may be excluded, consult factory.
- Must add original order number. Not for replacement parts or post sales issues, contact tech support or post sales teams. VM is used to ensure poles match in appearance exactly from order to order, on a single project site. A common use case would be a multi-phase project with multiple
- Must be quoted through AQD. Finishes do not require RFA. RAL colors available are shown in "Architectural Colors brochure". Lead times may be extended up to 2 weeks due to paint procurement.



POLE-RSA

OUTDOOR: 1 Acuity Way, Decatur, GA 30035 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com

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RSA Round Straight Aluminum Poles

TECHNICAL INFORMATION — EPA (FT²) WITH 1.3 GUST								
Catalog number	Nominal mounting height (ft.)*	Pole shaft size (in. x ft.)	Wall thickness (in.)	EPA (ft²) with 1.3 gust			Max. weight (lbs.)	Approx. ship weight (lbs.)
				80 MPH	90 MPH	100 MPH		
RSA 8 4C	8	4 x 8	0.125	11.2	8.6	6.8	125	22
RSA 8 4-5C	8	4-1/2 x 8	0.125	14.6	11.3	9.1	175	30
RSA 8 4-5G	8	4-1/2 x 8	0.188	21.8	17	13.7	225	38
RSA 10 4C	10	4 x 10	0.125	8.2	6.1	4.7	100	26
RSA 10 4-5C	10	4-1/2 x 10	0.125	10.6	8.1	6.5	133	34
RSA 10 4-5G	10	4-1/2 x 10	0.188	16.3	12.6	10.1	175	43
RSA 10 5C	10	5 x 10	0.125	13.6	10.6	8.5	150	36
RSA 12 4C	12	4 x 12	0.125	6	4.3	3.2	110	30
RSA 12 4-5C	12	4-1/2 x 12	0.125	8.1	6	4.8	80	38
RSA 12 4-5G	12	4-1/2 x 12	0.188	12.7	9.7	7.7	185	50
RSA 12 5C	12	5 x 12	0.125	10.3	8	6.3	150	36
RSA 12 5E	12	5 x 12	0.156	13.2	10.3	8.2	200	44
RSA 12 5G	12	5 x 12	0.188	16.2	12.6	10.1	225	53
RSA 14 4C	14	4 x 14	0.125	4.1	2.8	1.9	75	35
RSA 14 4-5C	14	4-1/2 x 14	0.125	5.8	4.2	3.3	60	39
RSA 14 4-5G	14	4-1/2 x 14	0.188	9.7	7.3	5.8	190	56
RSA 14 5C	14	5 x 14	0.125	7.8	6	4.7	100	42
RSA 14 5E	14	5 x 14	0.156	10.3	8	6.3	125	47
RSA 14 5G	14	5 x 14	0.188	12.8	9.9	7.9	150	56
RSA 16 4C	16	4 x 16	0.125	2.8	1.6	1	150	38
RSA 16 4-5C	16	4-1/2 x 16	0.125	3.3	2.2	1.6	100	46
RSA 16 4-5G	16	4-1/2 x 16	0.188	7.5	5.5	4.3	155	62
RSA 16 5C	16	5 x 16	0.125	5.9	4.4	3.4	175	46
RSA 16 5E	16	5 x 16	0.156	8	6.1	4.8	190	53
RSA 16 5G	16	5 x 16	0.188	10.1	7.8	6.1	200	60
RSA 16 6E	16	6 x 16	0.156	13.6	10.6	8.4	225	53
RSA 16 6G	16	6 x 16	0.188	16.8	13	10.4	245	78
RSA 18 5G	18	5 x 18	0.188	8	6.8	4.7	225	68
RSA 18 5C	18	5 x 18	0.125	4.3	3.1	2.4	150	48
RSA 18 5E	18	5 x 18	0.156	6.1	4.6	3.5	175	58
RSA 18 4-5G	18	4-1/2 x 18	0.188	5.7	4	3.1	123	68
RSA 18 6G	18	6 x 18	0.188	13.9	10.7	8.5	225	86
RSA 20 4-5G	20	4-1/2 x 20	0.188	4.3	2.9	2.1	95	74
RSA 20 5C	20	5 x 20	0.125	3	2.1	1.5	150	54
RSA 20 5E	20	5 x 20	0.156	4.7	3.4	2.6	150	68
RSA 20 5G	20	5 x 20	0.188	6.4	4.8	3.6	150	82
RSA 20 6E	20	6 x 20	0.156	9.3	7.1	5.5	175	95
RSA 20 6G	20	6 x 20	0.188	11.8	9.1	7.1	200	110
RSA 25 4-5G	25	4-1/2 x 25	0.188	1.3	--	--	100	89
RSA 25 6E	25	6 x 25	0.156	5.2	3.8	2.8	150	108
RSA 25 6G	25	6 x 25	0.188	7.1	5.3	4	150	128
RSA 30 6G	30	6 x 30	0.188	3.5	2.4	1.6	200	146

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.



POLE-RSA

OUTDOOR: 1 Acuity Way, Decatur, GA 30035 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com

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RSA Round Straight Aluminum Poles

TECHNICAL INFORMATION — EPA (ft²) WITH 3-SECOND GUST PER AASHTO 2013																	
Series	Nominal mounting height (ft.)*	Shaft base size	90 MPH	Max. weight	100 MPH	Max. weight	110 MPH	Max. weight	120 MPH	Max. weight	130 MPH	Max. weight	140 MPH	Max. weight	150 MPH	Max. weight	Approx. ship weight (lbs.)
RSA	8	4C	7.3	75	5.7	75	4.5	75	3.7	75	3.1	75	2.6	75	2.3	75	22
RSA	8	4-5C	10.2	100	8	100	6.5	100	5.4	100	4.6	100	3.9	100	3.4	100	30
RSA	8	4-5G	15.1	100	12.1	100	9.8	100	8.2	100	7	100	6	100	5.1	100	38
RSA	10	4C	5.5	75	4.2	75	3.2	75	2.6	75	2.1	75	1.8	75	1.5	75	26
RSA	10	4-5C	7.9	100	6.1	100	4.9	100	4	100	3.4	100	2.8	100	2.4	100	34
RSA	10	4-5G	12	100	9.4	100	7.6	100	6.3	100	5.3	100	4.5	100	3.9	100	43
RSA	10	5C	10.6	100	8.4	100	6.9	100	5.7	100	4.8	100	4.1	100	3.5	100	36
RSA	12	4C	4.1	75	3	75	2.2	75	1.6	75	1.3	75	1.1	75	0.9	75	30
RSA	12	4-5C	6.1	100	4.6	100	3.6	100	2.9	100	2.4	100	2	100	1.7	100	38
RSA	12	4-5G	9.6	100	7.4	100	5.9	100	4.9	100	4.1	100	3.5	100	2.9	100	50
RSA	12	5C	8.4	100	6.6	100	5.3	100	4.4	100	3.7	100	3.1	100	2.6	100	36
RSA	12	5E	10.8	100	8.5	100	6.9	100	5.7	100	4.8	100	4.1	100	3.5	100	44
RSA	12	5G	13.1	100	10.4	100	8.5	100	7	100	5.9	100	5	100	4.3	100	53
RSA	14	4C	3	75	2	75	1.3	75	0.9	75	0.6	75	0.5	75	-	-	35
RSA	14	4-5C	4.6	100	3.3	100	2.5	100	2	100	1.6	100	1.3	100	1.1	100	39
RSA	14	4-5G	7.7	100	5.8	100	4.6	100	3.7	100	3.1	100	2.6	100	2.2	100	56
RSA	14	5C	6.6	100	5.1	100	4	100	3.3	100	2.7	100	2.3	100	1.9	100	42
RSA	14	5E	8.7	100	6.7	100	5.4	100	4.5	100	3.7	100	3.1	100	2.6	100	47
RSA	14	5G	10.7	100	8.4	100	6.8	100	5.6	100	4.7	100	4	100	3.4	100	56
RSA	16	4C	2	75	1.2	75	0.6	75	-	-	-	-	-	-	-	-	38
RSA	16	4-5C	3.3	100	2.2	100	1.6	100	1.2	100	0.9	100	0.7	100	0.5	100	46
RSA	16	4-5G	6	100	4.4	100	3.3	100	2.7	100	2.2	100	1.8	100	1.5	100	62
RSA	16	5C	5	100	3.7	100	2.9	100	2.3	100	1.9	100	1.5	100	1.3	100	46
RSA	16	5E	6.8	100	5.2	100	4.1	100	3.3	100	2.7	100	2.3	100	1.9	100	53
RSA	16	5G	8.6	100	6.6	100	5.3	100	4.4	100	3.6	100	3	100	2.5	100	60
RSA	16	6E	13.1	100	10.5	100	8.5	100	7	100	5.9	100	5	100	4.3	100	53
RSA	16	6G	16.1	100	12.9	100	10.5	100	8.7	100	7.3	100	6.2	100	5.3	100	78
RSA	18	5G	6.8	100	5.1	100	4.1	100	3.3	100	2.7	100	2.2	100	1.8	100	68
RSA	18	5C	3.6	100	2.6	100	2	100	1.5	100	1.2	100	0.9	100	0.7	100	48
RSA	18	5E	5.2	100	3.9	100	3	100	2.4	100	1.9	100	1.5	100	1.3	100	58
RSA	18	4-5G	4.6	100	3.1	100	2.3	100	1.8	100	1.4	100	1.1	100	0.9	100	68
RSA	18	6G	13.4	100	10.6	100	8.6	100	7.1	100	5.9	100	5	100	4.3	100	86
RSA	20	4-5G	3.3	100	2.1	100	1.4	100	1	100	0.7	100	0.5	100	-	-	74
RSA	20	5C	2.4	100	1.6	100	1.1	100	0.8	100	0.5	100	-	-	-	-	54
RSA	20	5E	3.8	100	2.7	100	2	100	1.6	100	1.2	100	0.9	100	0.7	100	68
RSA	20	5G	5.2	100	3.8	100	3	100	2.3	100	1.9	100	1.5	100	1.2	100	82
RSA	20	6E	8.8	100	6.9	100	5.5	100	4.5	100	3.7	100	3.1	100	2.6	100	95
RSA	20	6G	11.1	100	8.7	100	7	100	5.8	100	4.8	100	4	100	3.4	100	110
RSA	25	4-5G	0.8	100	-	-	-	-	-	-	-	-	-	-	-	-	89
RSA	25	6E	4.9	100	3.7	100	2.8	100	2.2	100	1.7	100	1.3	100	1	100	108
RSA	25	6G	6.7	100	5.1	100	4	100	3.2	100	2.5	100	2.1	100	1.7	100	128
RSA	30	6G	3.4	100	2.4	100	1.7	100	1.2	100	0.8	100	0.6	100	-	-	146

NOTES: AASHTO 2013 design criteria is the most common EPA and uses wind map ASCE7-05. Please review the project Spec document to determine the correct design criteria for the poles on your jobsite.

1) Maximum EPA (Effective Projected Area) and weight values are based on the load centroid being 2.5' above the pole top and with 2' eccentricity.

Variations from the sizes above are available upon inquiry at the factory. Satisfactory performance of poles is dependent upon the pole being properly attached to a supporting foundation of adequate design.

2) Structure weight is a nominal value which includes the pole shaft and base plate only.

*For 1/2 ft increments, add -6 to the pole height. Ex: 20-6 equals 20ft 6in.



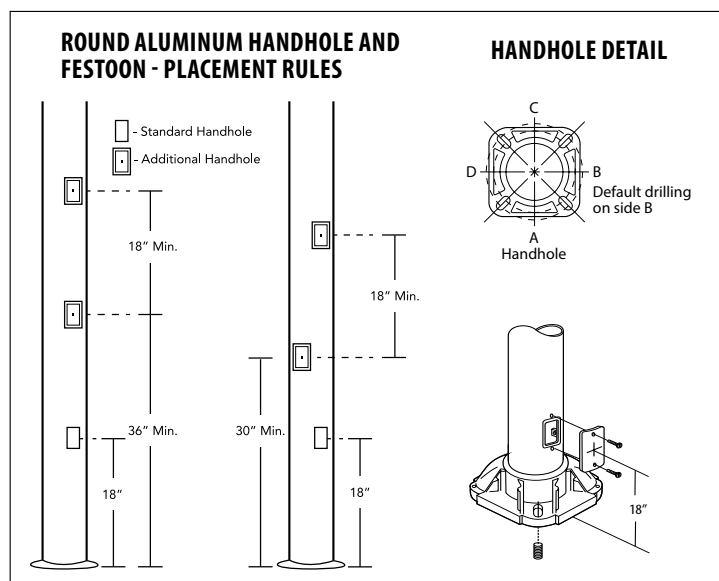
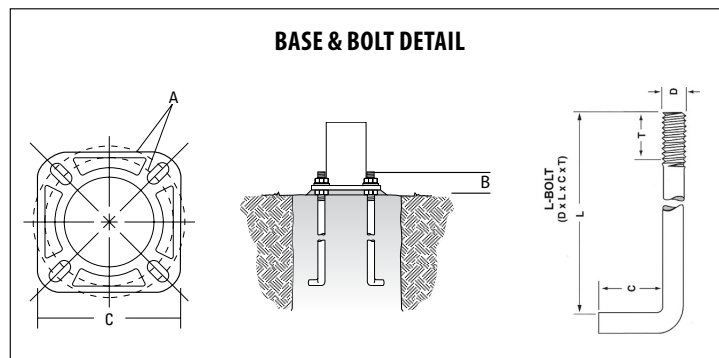
POLE-RSA

OUTDOOR: 1 Acuity Way, Decatur, GA 30035 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com

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RSA Round Straight Aluminum Poles

ANCHORAGE AND TEMPLATE INFORMATION						
Shaft base size	Bolt circle A	Bolt projection B	Base diameter C	Template description	Anchor bolt description	Bolt size (in.) D x L x C
4"	6.75" - 8.00"	3.25"	8.91"	ABTEMPLATE PJ50057	AB18-0	3/4 x 18 x 3
4.5"	7.50" - 8.00"	3.25"	9.26"	ABTEMPLATE PJ50040	AB18-0	3/4 x 18 x 3
5"	7.50" - 8.00"	3.25"	9.61"	ABTEMPLATE PJ50058	AB18-0	3/4 x 18 x 3
6"	9.00"-10.00"	3.50"	10.32"	ABTEMPLATE PJ50059	AB30-0	3/4 x 30 x 3



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.

CAUTION: These specifications are intended for general purposes only. Lithonia Lighting reserves the right to change material or design, without prior notice, in a continuing effort to upgrade its products.



POLE-RSA

OUTDOOR: 1 Acuity Way, Decatur, GA 30035 Phone: 800-705-SERV (7378) TechSupport-Lighting@Acuitybrands.com www.lithonia.com

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Specification Sheet

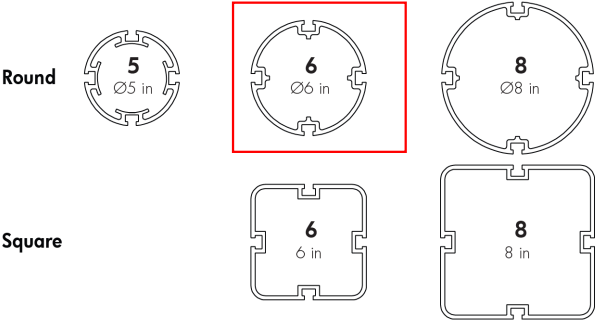
Lumentech
Smart Pole

28' POLE PL - T

APPROVED ALTERNATE MANUFACTURERS:
1. LUMCA RAIL POLE
2. HAPCO SMART TRAC

Project Name _____ Qty _____

Type _____ Catalog / Part Number _____



Available Pole Shapes
Up to 28 ft (Specify Height in 1 ft increments)

Base cover options



Description

The Lumentech Smart Pole is compatible with a number of Lumenpulse outdoor fixtures and accessories. Available in various heights, finishes and designed to be future-proof, the Lumentech Smart Pole is an instant contemporary classic.

Features

Dimensions	5 in , 6 in , 8 in
Shapes	Round , Square
Height	Up to 28 ft (specify height in 1 ft increments)
Warranty	5-year limited warranty
Option	Ground Fault Duplex Receptacle Ground Fault Duplex Receptacle (while in use) Tamper-Proof Screws Corrosion-resistant Coating for Hostile Environments Pressure Gland drilling pattern Universal Yoke drilling pattern Hook

Physical

Material	Aluminum
Cap Material	Aluminum (included)
Hardware Material	Stainless steel
Surface Finish	Super durable resistant exterior polyester powder coating meets AAMA 2604-98 requirements (5-years Florida exposure). A corrosion resistant finish (CRC) pre-finish is available to meet ASTM B-117 & ASTM D-1654 (salt spray resistance) and ASTM D-2247 requirements (humidity resistance).



1220 Marie-Victorin Blvd., Longueuil, QC, J4G 2H9, CAN | T 514.937.3003 | Toll-Free 1.877.937.3003 | info@lumenpulse.com
www.lumenpulse.com www.lumenpulse.com/products/3615

LMPG Inc. reserves the right to make changes to this product at any time without prior notice and such modification shall be effective immediately.
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JC - R19

How to Order

Pole	Dimensions	Shapes	Height	Finish	Base Cover Options	Pole Top Options ⁽⁴⁾	Option	Anchor Bolts Option
PL-T Lumentech Pole	5 5 in	R Round	10 10 ft	BK Black Sandtex®	SB Square Base Cover SB for 6 in and 8 in Pole ⁽⁴⁾	B LDS-S1E Simple Drilling Pattern for Lumenblade Small ⁽⁷⁾	DRG Ground Fault Duplex Receptacle ⁽⁹⁾	AB Anchor Bolts ⁽¹³⁾
	6 6 in		11 11 ft		SC Square Base Cover SC for 8 in Pole ⁽⁴⁾	B LDS-S2E Double Drilling Pattern for Lumenblade Small ⁽⁷⁾	DRG IU Ground Fault Duplex Receptacle (while in use) ⁽⁹⁾	
	8 8 in	S Square	12 12 ft	BRZ Bronze Sandtex®	WA Round Base Cover WA for 5 in Pole ⁽⁵⁾	B LDM-S1E Simple Drilling Pattern for Lumenblade Medium ^{(7) (8)}	TP Tamper-Proof Screws	
			13 13 ft	BRZTX Textured Bronze Non-Metallic	WC Round Base Cover WC for 5 in Pole ⁽⁵⁾	B LDM-S2E Double Drilling Pattern for Lumenblade Medium ^{(7) (8)}	CRC Corrosion-resistant coating ⁽¹⁰⁾	
			14 14 ft	GRATX Textured Medium Gray	WF Round Base Cover WF for 5 in Pole ⁽⁵⁾	B LDM-S1E-3GV Simple Drilling Pattern for Lumenblade Medium (for 3G ANSI C136.31-2010 Vibration Rating for bridge applications) ⁽⁸⁾	PG Pressure Gland drilling pattern ⁽¹¹⁾	
			15 15 ft	GRNTX Textured Green	WH Round Base Cover WH for 5 in Pole ⁽⁵⁾	B LDM-S2E-3GV Double Drilling Pattern for Lumenblade Medium (for 3G ANSI C136.31-2010 Vibration Rating for bridge applications) ⁽⁸⁾	PLTU Universal Yoke drilling pattern ⁽¹¹⁾	
			16 16 ft	SI Silver Sandtex®	WI Round Base Cover WI for 5 in Pole ⁽⁵⁾	B LDS-S1E-3GV Simple Drilling Pattern for Lumenblade Small (for 3G ANSI C136.31-2010 Vibration Rating for bridge applications)	HK Hook ⁽¹²⁾	
			17 17 ft	CC Custom Color & Finish ^{(1) (2) (3)}	WJ Round Base Cover WJ for 5 in Pole ⁽⁵⁾	B LDS-S2E-3GV Double Drilling Pattern for Lumenblade Small (for 3G ANSI C136.31-2010 Vibration Rating for bridge applications)		
			18 18 ft		WL Round Base Cover WL for 5 in Pole ⁽⁵⁾			
			19 19 ft		WM Round Base Cover WM for 5 in Pole ⁽⁵⁾			
			20 20 ft		WO Round Base Cover WO for 5 in and 6 in Pole ⁽⁵⁾			
			21 21 ft		WP Round Base Cover WP for 5 in Pole ⁽⁵⁾			
			22 22 ft		WR Round Base Cover WR for 5 in Pole ⁽⁵⁾			
			23 23 ft		WS Round Base Cover WS for 5 in Pole ⁽⁵⁾			
			24 24 ft		WY Round Base Cover WY for 5 in Pole ⁽⁵⁾			
			25 25 ft		WYX Round Base Cover WYX for 5 in Pole ⁽⁵⁾			
			26 26 ft					
			27 27 ft					
			28 Maximum height 28 ft					

Notes:

- Specify RAL number followed by "TX" for textured finish (ex: RAL9007TX) or STX for Sandtex finish (ex: RAL9007STX). Textured or Sandtex finishes are recommended for the durability of all products. If a finish is not specified with the RAL number (ex: RAL9007), a glossy finish will be provided. Please consult factory for other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
- Setup charges apply for RAL colors. Consult factory for details.
- Longer lead times can be expected for custom RAL color finishes.
- Available with round and square pole.
- Available with round pole only.
- Available with 5 in and 6 in pole dimensions only.
- Flat cap included.
- Available with 6 in and 8 in pole dimensions only.
- Not available with 6 in square pole.
- Use only when exposed to salt spray. This option is not required for normal outdoor exposure.
- Consult factory for details.
- Not available with Pole Top Options.
- Anchor bolts provided with double nuts, washers and template. One template provided for every 5 poles.

Certifications



Pole Top Options	Simple and Double Drilling Pattern for Lumenblade Small and Lumenblade Medium, Simple and Double Drilling Pattern for Lumenblade Small and Lumenblade Medium (for 3G ANSI C136.31-2010 Vibration Rating for bridge applications).
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Grounding Terminal	Copper single-conductor (UL listed, accessible from pole hand hole)
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Environmental

Environment	Dry/damp/wet location
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Accessories (Optional, Specify in Order Code)

Decorative Base Cover

Accessories - optional (Order Separately)

Arms	Banner Arm (top only, or top and bottom) Plant Holder Arm (single or double)
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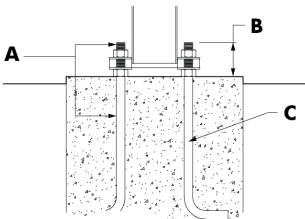
Fixture Mounting	Universal Yoke
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Hardware	Pressure Gland Street Sign Holder Small Skate for Lumentech Large Skate for Lumentech Hook
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Control Boxes	Vertical CBOX (consult factory)
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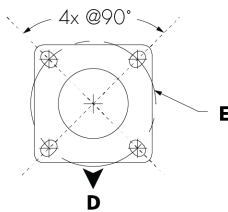
Anchoring Details

Anchor Details



- A - Galvanized Steel portion
B - The threads of Anchor Bolts must protrude at least 3 in from concrete base.
C - (4X) Anchor Bolts, supplied with two Nuts and Flats Washers for each (provided)

Bolt Circle

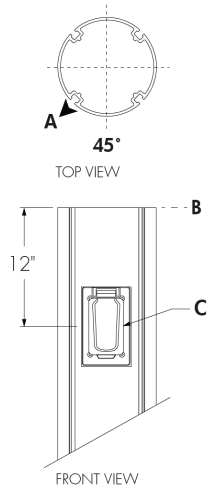


- D - Access Door and Street Side
E - Bolt Circle

Shapes	Anchor Bolts	Bolt Circle
5 in	Ø3/4 in x 26 in	Ø10 in
6 in	Ø1 in x 36 in	Ø14 in
8 in	Ø1 in x 36 in	Ø14 in

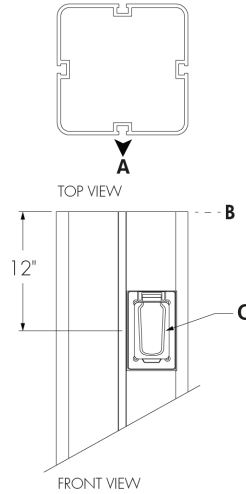
Ground Fault Duplex Receptacle Options Detail

Round Pole Shape



- A** - Door Side
B - Top of Pole
C - Standard location of Ground Fault Duplex Receptacle (DRG and DRG IU) is 12 in from the top, 45° from the Door Side (consult factory for others configuration).

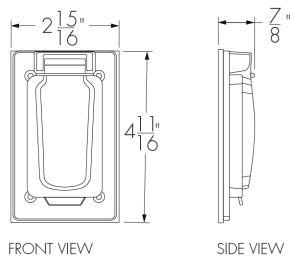
Square Pole Shape



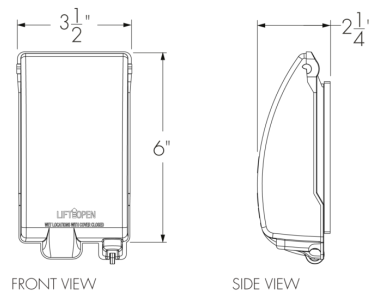
- A** - Door Side
B - Top of Pole
C - Standard location of Ground Fault Duplex Receptacle (DRG and DRG IU) is 12 in from the top on Door Side, right side of the slide (consult factory for others configuration).

Duplex Receptacle Installation Dimensions

DRG - Ground Fault Duplex Receptacle



DRG IU - Ground Fault Duplex Receptacle (while in use)*



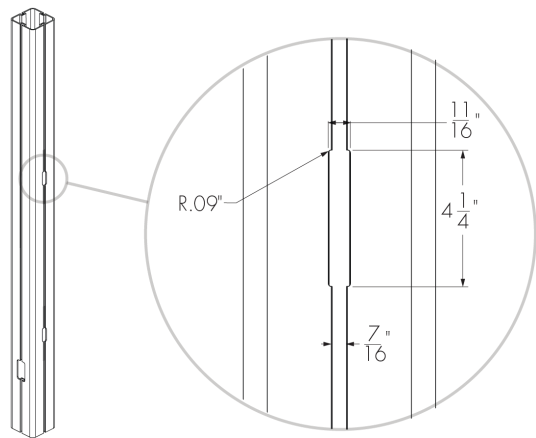
* Weather-resistant and lockable cover (padlock by others)

The duplex receptacle must be installed in accordance with applicable national and local electrical and construction codes by a person familiar with the construction and operation of the product and the hazards involved. Refer to national and local electrical codes before selecting a duplex receptacle to ensure all requirements are met.

DRG and DRG IU are available for 5 in, 6 in and 8 in round profiles, and 8 in square profiles only.

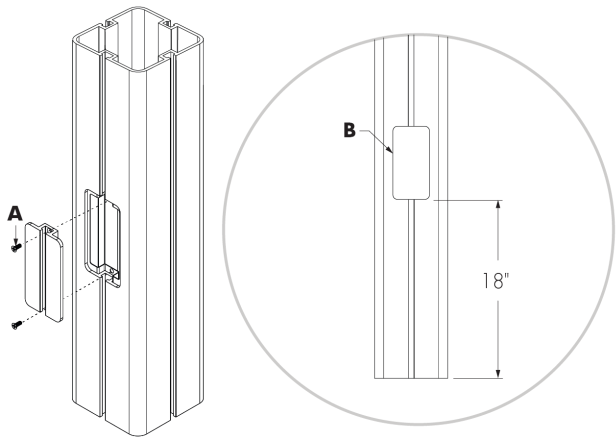
Details And Dimensions

Quick Insert Aperture For Skate Accessories



The lumentech Smart Pole is delivered with 2 quick insert apertures per side as standard (Access Door count as 1 aperture, consult factory for other configurations).

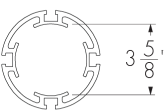
Access Door



- A** - (2x) 10-32 Bolts (included)
B - Access Door Dimensions:
- Ø 5 in Pole: 2 1/8 in x 4 in
- Ø 6 in and Ø 8 in Pole: 3 in x 6 in

Interior Dimensions

Round 5in



Top View

Round 6in



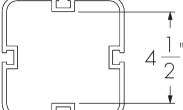
Top View

Round 8in



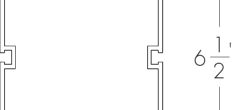
Top View

Square 6in



Top View

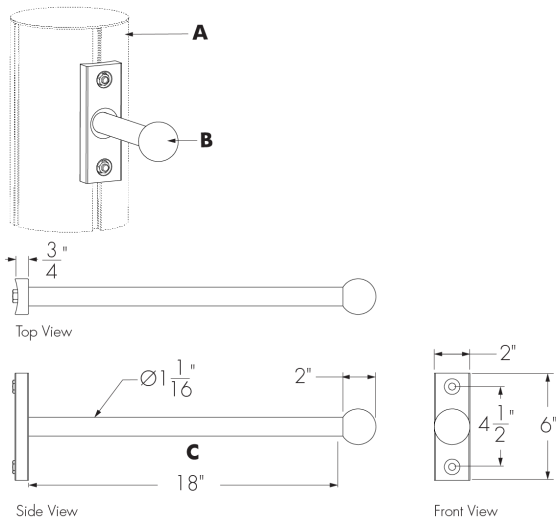
Square 8in



Top View

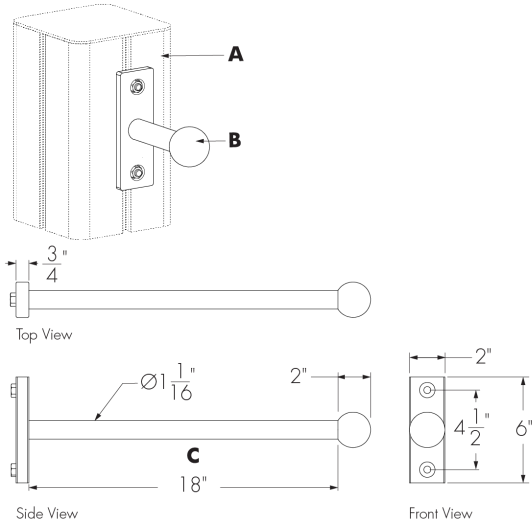
Accessories (Order Separately)

BA - Banner Arm for Round Pole*



- A - Round Technical Pole
- B - Banner Arm (mounting hardware included)
- BA-1: Banner Arm (top only)
- BA-2: Banner Arm (top and bottom)
- C - Standard length 18 in (consult factory for any other length requirement)

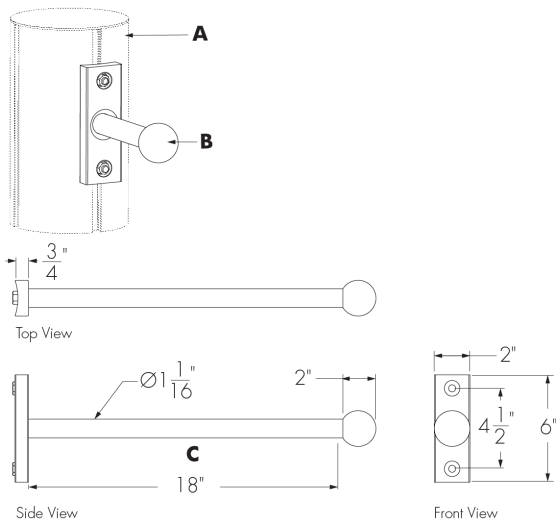
BA - Banner Arm for Square Pole*



- A - Square Technical Pole
- B - Banner Arm (mounting hardware included);
- BA-1: Banner Arm (top only)
- BA-2: Banner Arm (top and bottom)
- C - Standard length 18 in (consult factory for any other length requirement)

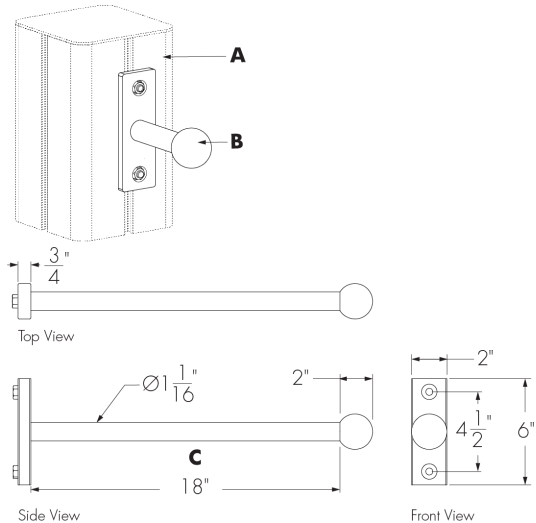
* Specify banner dimensions, installation height and orientation in the Ordering Specifications section.
Consult Banner Arm specification sheet for details.

PH - Plant Holder Arm for Round Pole*



- A** - Round Technical Pole
B - Plant Holder Arm (mounting hardware included)
PH-PLT: Plant Holder Arm
C - Standard length 18 in (consult factory for any other length requirement)

PH - Plant Holder Arm for Square Pole*



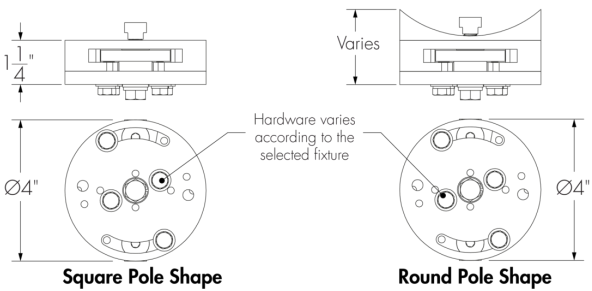
- A** - Square Technical Pole
B - Plant Holder Arm (mounting hardware included);
PH-PLT: Plant Holder Arm
C - Standard length 18 in (consult factory for any other length requirement)

* Specify basket dimensions and weight (maximum load 80 lbs wet), as well as installation height and orientation in the Ordering specifications section.
Consult Plant Holder Arm specification sheet for details.

PLTU - Universal Yoke*

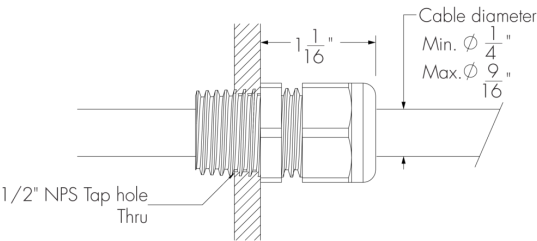
Allows for the easy installation, as well as the full rotation and pivoting, of luminaires and accessories. Greatly enhances and increases lighting design flexibility.

A - Fixed part (Skate included)
B - 360° swivel part
C - (2X) 1/4-20 Bolts (included, use to assemble 360° swivel part to fixed part)
D - Skate
E - (2X) 3/8-16 Bolts
F - (2X) Lock Washer
G - (2X) Flats Washer
H - For 3/8-16 or 1/4-20 Bolts (included when ordered with a Lumenbeam products, refer to Drilling Pattern of installation instruction for more details)



*Specify weight and dimensions of your own accessories in Ordering specifications section.
Consult Universal Yoke specification sheet for details.

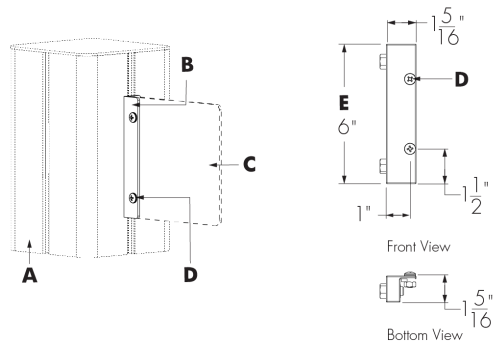
PG - Pressure Gland



- A** - Pole Wall
B - Pressure Gland
C - Cable (by others)

Consult Pressure Gland specification sheet for details.

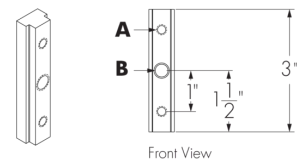
SSH - Street Sign Holder*



- A - Technical Pole (Square Shape Shown)
- B - Street Sign Holder (mounting hardware included)
- C - Street Sign (provided by others)
- D - (2X) 1/4-20 Bolt (included)
- E - Standard height of 6 in (consult factory for other height requirement)

* Specify the dimensions of the panel to be installed on the Street Sign Holder and the height and orientation of installation in the Ordering Specifications section.
Consult Street Sign Holder specification sheet for details.

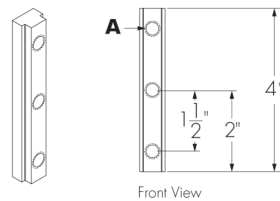
SSK - Small Skate For Lumentech*



- A - For (2X) 1/4-20 Bolts (included)
- B - For (1X) 3/8-16 Bolts (included)

Consult Small and Large Skate specification sheet for details.

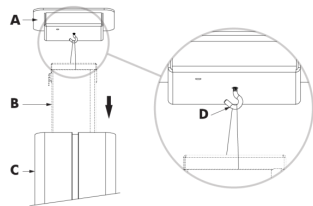
LSK - Large Skate For Lumentech*



- A - For (3X) 3/8-16 Bolts (included)

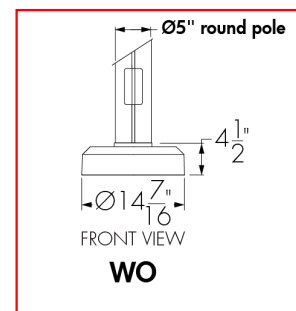
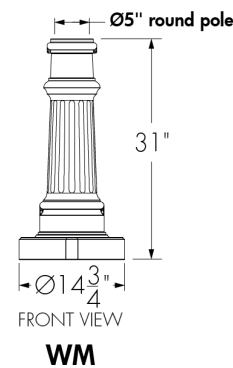
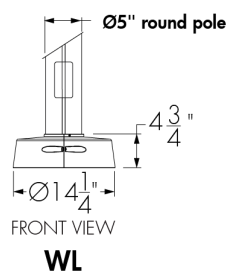
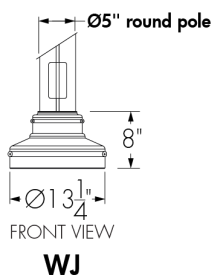
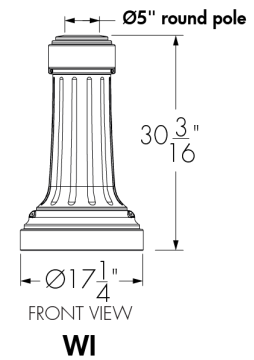
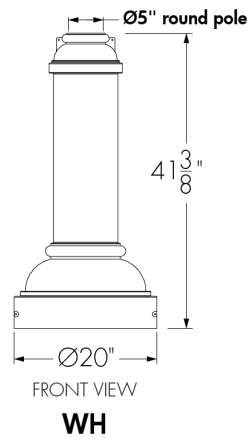
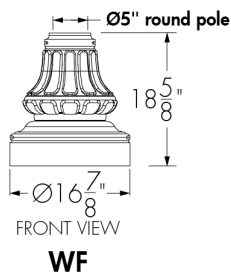
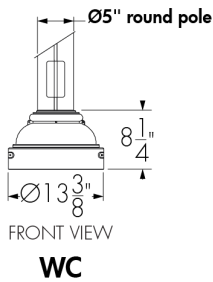
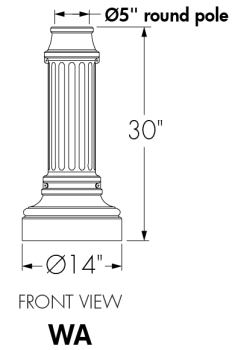
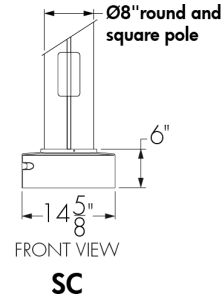
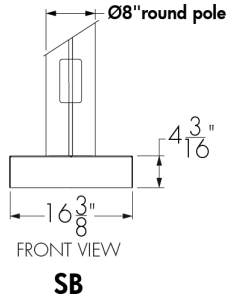
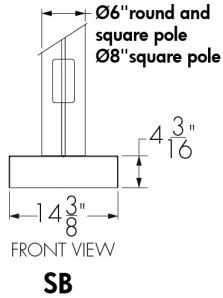
Accessories (Optional, Specify in Order Code)

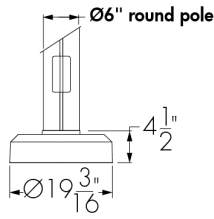
HK - Hook



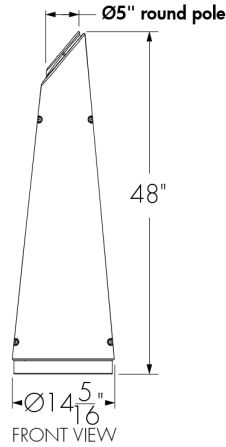
- A - Cap (included)
- B - Vertical control box (consult factory)
- C - Technical pole (square shape shown, see interior dimensions section for available space)
- D - Hook

Base Cover Options Dimensions

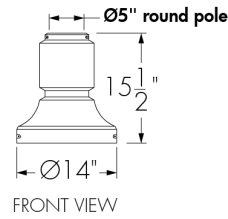




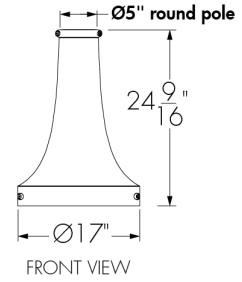
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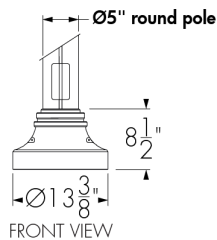
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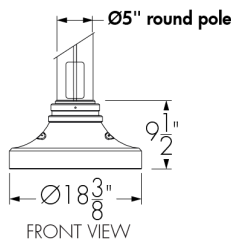
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WS



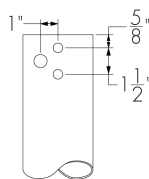
WY



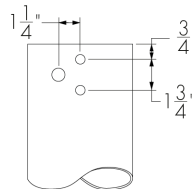
WYX

Pole Top Options Details

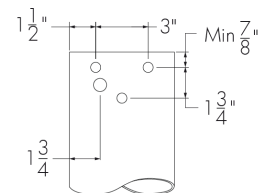
BLDS-S1E ^[1], BLDS-S2E ^[2], BLDS-S1E-3GV ^[1] and BLDS-S2E-3GV ^[2] - Drilling pattern for Lumenblade Small ^[3]



BOLD-S1E ^[1] and BOLD-S2E ^[2] - Drilling pattern for Lumenblade Medium ^[3]



BOLD-S1E-3GV ^[1] and BOLD-S2E-3GV ^[2] - Drilling Pattern For Lumenblade Medium ^[3]



[1] Standard orientation for **S1E** configuration is 0° (access door)

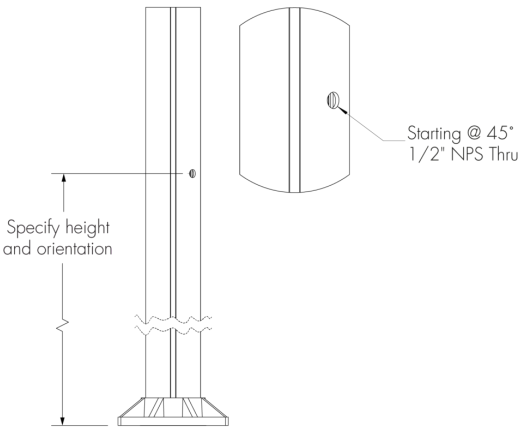
[2] Standard orientation for **S2E** configuration is 180° from access door.

[3] Flat cap included.

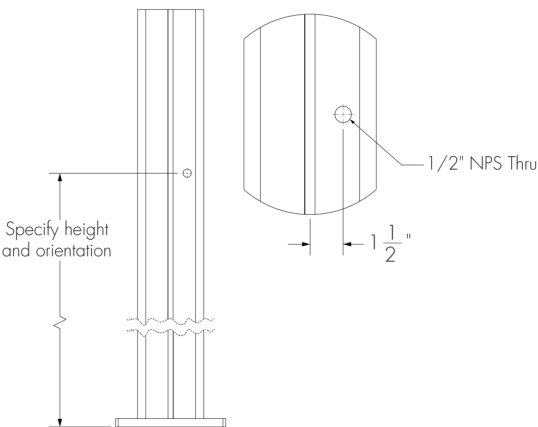
Pole Accessory Drilling Patterns

PG - Pressure Gland Drilling Pattern

Round Pole Shape

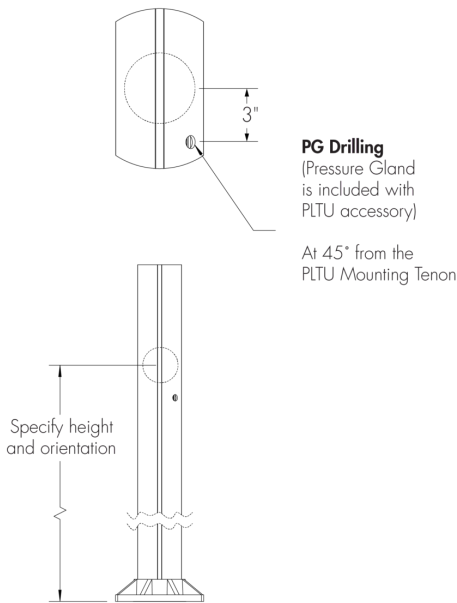


Square Pole Shape

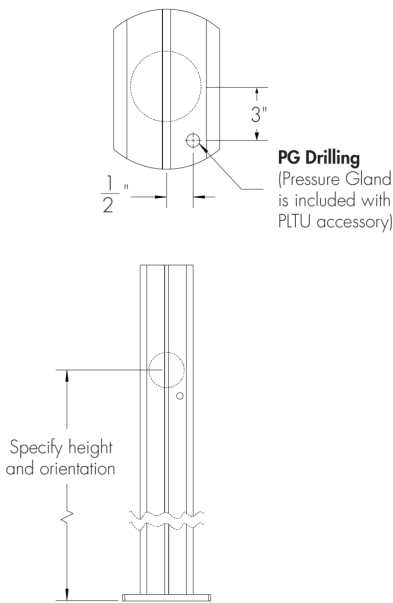


PLTU - Universal Yoke Drilling Pattern

Round Pole Shape



Square Pole Shape



Ordering Specifications
(Specifications Are Used For EPA Calculations)*

180°

270°

90°

0°

(Access door)

180°

270°

90°

0°

(Access door)

	Product code	Orientation (0°, 90°, 180°, 270°)	Height (consult "configuration table" section for maximum height)	Weight (please specify weight of accessories)	Dimensions (please specify dimensions of accessories)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

* In addition to specifying installation height and orientation, don't forget to include specific details for each accessory:

Universal Yoke (PLTU)/Small and Large Skate for Lumentech (SSK, LSK)

- If used with a fixture from another manufacturer, consult factory.

Banner Arm (BA)

- Specify banner dimensions.

Street Sign holder (SSH)

- Specify dimensions of sign to be mounted on Street Sign Holder.

Plant Holder Arm (PH)

- Specify basket size and weight (maximum 80 lbs wet).

Pressure Gland (PG)

- If used with a fixture from another manufacturer, specify the weight and dimensions of this fixture.

Compatible Lumenpulse Products

(Order Separately, Consult Related Specification Sheets for Details)

1. **LBS** - Lumenbeam Small

2. **LBM** - Lumenbeam Medium

3. **LBL** - Lumenbeam Large

4. **LBG** - Lumenbeam Grande

5. **LBX** - Lumenbeam LBX

6. **LQL** - Lumenquad Large

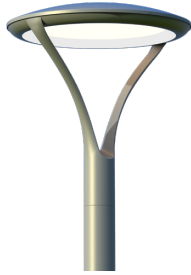
7. **LQG** - Lumenquad Grande

8. **PUR100** - Pure 100

9. **LIAM** - Lumenicon Area Medium

10. **BLDS** - Lumenblade Small

11. **BLDM** -Lumenblade Medium



Radean Post Top LED Area Luminaire



APPROVED ALTERNATE MANUFACTURERS:
1. PACIFICA "PT2 PLED" SERIES
2. COOPER INVUE "LXS LUXESCAPE" SERIES

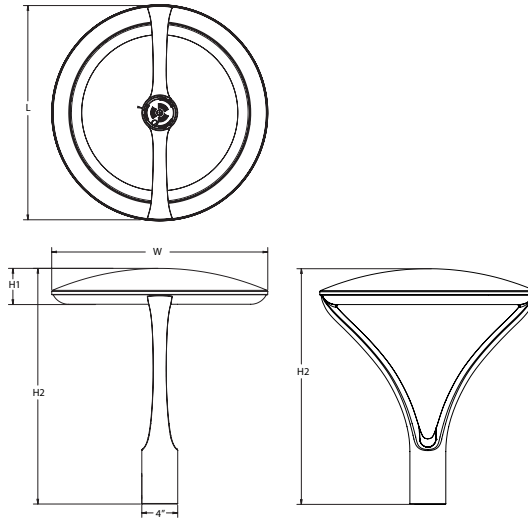
Notes

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Specifications

EPA: 1.02 ft²
(0.105 m²)
Length: 24"
(61cm)
Width: 24"
(61cm)
H1 Luminaire Height: 4"
(10.16cm)
H2 Luminaire Height: 26"
(66.04cm)
Weight: 38lbs
(17.24Kg)



Introduction

The architecturally-inspired shape of the RADEAN™ post top area luminaire embodies the grace and strength of the RADEAN family. The twin copper-core cast aluminum arms support the slender superstructure, creating a beautiful sculpture by day transforming into a beacon of comfort by night. Triangular arms redirect reflection maintaining its visually quiet appearance. With sleek lines and simple silhouettes, these LED luminaires use specialized lighting and visual comfort to transform common areas like courtyards, outdoor retail locations, universities and corporate campuses into pedestrian-friendly nighttime environments.

Ordering Information

EXAMPLE: RADPT LED P3 30K SYM MVOLT PT4 PE DNAXD

RADPT LED					
Series	Performance package	Color temperature	Distribution	Voltage	Mounting (required)
RADPT LED	P1 3,000 Lumens	27K 2700K	SYM Symmetric type V	MVOLT ² 277 ²	PT4 ³ Slips inside a 4" OD round metal pole
	P2 5,000 Lumens	30K 3000K	ASY Asymmetric type IV	120 ² 347	RADPT20 Slips over a 2 3/8" diameter tenon (4" tall tenon required)
	P3 7,000 Lumens	35K 3500K	PATH Pathway Type III	208 ² 480	RADPT25 Slips over a 2 7/8" diameter tenon (4" tall tenon required)
	P4 10,000 Lumens	40K 4000K		240 ²	
	P5 15,000 Lumens	50K 5000K			
Control options		Other options		Finish (required)	
Shipped installed		Shipped installed			
NLTAIR2	nLight AIR 2.0 enabled ⁴	SF Single Fuse ²	HS Houseside shield ⁷	DDBXD Dark bronze	DDBTXD Textured dark bronze
PE	Button photocell ⁴	DF Double Fuse ²		DBLXD Black	DBLTXD Textured black
FAO	Field adjustable output ⁴	R90 Rotated optics ⁶		DNAXD Natural aluminum	DNATXD Textured natural aluminum
DMG	0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately) ⁵			DWHXD White	DWHGXD Textured white



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RADPT LED
Rev. 11/14/24

Ordering Information

Accessories

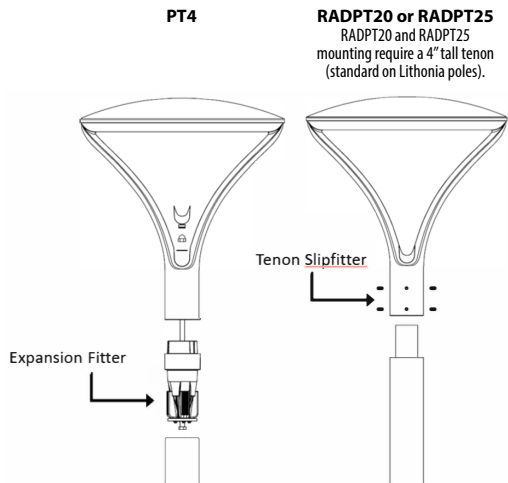
Ordered and shipped separately.

RADHS	Houseside shield (shield is white)
RADFC DBXD U	Full base cover for 4" RSS pole (specify finish)

NOTES

- 2700K and 3500K may require extended lead-times.
- MVOLT driver operates on any line voltage from 120-277V (50/60 Hz). Single fuse (SF) requires 120, 277 or 347 voltage option. Double fuse (DF) requires 208, 240 or 480 voltage option.
- Requires nominal 4" round straight metal pole.
- NLTAIR2 not available with PE or FAO. Must link to external nLight Air network. Does not include occupancy sensor. For more information refer to [rSBOR](#) pole mount sensor.
- DMG not available with NLTAIR2 or FAO.
- For left rotation, select R90 and rotate luminaire 180° on pole.
- Also available as a separate accessory; see Accessories information at left. HS not available with R90. Shield is field rotatable shield in 180° increments.

Mounting

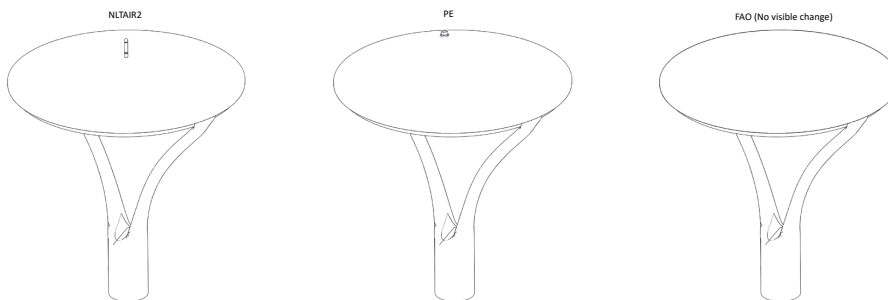


Recommended Poles for use with RADEAN RADPT LED Luminaires.

Acuity Part Number	Description	For luminaires	Used with Mounting
RSS 10 4B PT DBXD	10' Round Straight Steel - 4" O.D. - Open Top	RADPT LED	PT4
RSS 12 4B PT DBXD	12' Round Straight Steel - 4" O.D. - Open Top	RADPT LED	PT4
RSS 14 4B PT DBXD	14' Round Straight Steel - 4" O.D. - Open Top	RADPT LED	PT4
RSS 16 4B PT DBXD	16' Round Straight Steel - 4" O.D. - Open Top	RADPT LED	PT4
RSS 18 4B PT DBXD	18' Round Straight Steel - 4" O.D. - Open Top	RADPT LED	PT4
RSS 20 4B PT DBXD	20' Round Straight Steel - 4" O.D. - Open Top	RADPT LED	PT4
RSS 25 4B PT DBXD	25' Round Straight Steel - 4" O.D. - Open Top	RADPT LED	PT4
RSS 10 4B T20 DBXD	10' Round Straight Steel - 4" O.D. - Tenon Top	RADPT LED	RADPT20
RSS 12 4B T20 DBXD	12' Round Straight Steel - 4" O.D. - Tenon Top	RADPT LED	RADPT20
RSS 14 4B T20 DBXD	14' Round Straight Steel - 4" O.D. - Tenon Top	RADPT LED	RADPT20
RSS 16 4B T20 DBXD	16' Round Straight Steel - 4" O.D. - Tenon Top	RADPT LED	RADPT20
RSS 18 4B T20 DBXD	18' Round Straight Steel - 4" O.D. - Tenon Top	RADPT LED	RADPT20
RSS 20 4B T20 DBXD	20' Round Straight Steel - 4" O.D. - Tenon Top	RADPT LED	RADPT20
RSS 25 4B T20 DBXD	25' Round Straight Steel - 4" O.D. - Tenon Top	RADPT LED	RADPT20

* Customer must verify pole loading per required design criteria and specified wind speed. Consult pole specification sheet for additional details.

Control Options



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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. Contact factory for performance data on any configurations not shown here.

Performance Package	Input Wattage	Distribution	2700K					3000K					3500K					4000K					5000K				
			Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P1	25	ASY	2,924	2	1	2	115	3,022	2	2	2	119	3,095	2	2	2	122	3,168	2	2	2	125	3,168	2	2	2	125
		PATH	2,529	2	1	2	100	2,613	2	2	2	103	2,676	2	2	2	105	2,739	2	2	2	108	2,739	2	2	2	108
		SYM	3,086	2	1	1	121	3,189	2	1	1	126	3,266	2	1	1	129	3,344	2	1	1	132	3,344	2	1	1	132
P2	38	ASY	4,521	3	2	3	119	4,672	3	2	3	123	4,785	3	2	3	126	4,898	3	2	3	129	4,898	3	2	3	129
		PATH	3,909	2	2	2	103	4,040	2	2	2	106	4,137	2	2	2	109	4,235	3	2	3	111	4,235	3	2	3	111
		SYM	4,772	2	2	1	126	4,931	3	2	1	130	5,050	3	2	1	133	5,169	3	2	1	136	5,169	3	2	1	136
P3	54	ASY	6,387	3	2	3	119	6,600	3	2	3	123	6,760	3	2	3	126	6,919	3	2	3	129	6,919	3	2	3	129
		PATH	5,523	3	2	3	103	5,707	3	2	3	106	5,845	3	2	3	109	5,983	3	2	3	112	5,983	3	2	3	112
		SYM	6,741	3	2	2	126	6,966	3	2	2	130	7,135	3	2	2	133	7,303	3	2	2	136	7,303	3	2	2	136
P4	86	ASY	10,150	4	2	4	118	10,489	4	2	4	122	10,742	4	2	4	125	10,996	4	2	4	128	10,996	4	2	4	128
		PATH	8,777	3	2	3	102	9,070	3	2	3	106	9,289	3	2	3	108	9,509	3	2	3	111	9,509	3	2	3	111
		SYM	10,713	3	2	2	125	11,071	3	2	2	129	11,338	3	2	2	132	11,606	3	2	2	135	11,606	3	2	2	135
P5	123	ASY	14,250	4	2	4	116	14,724	4	2	4	120	15,081	4	3	4	123	15,437	4	3	4	126	15,437	4	3	4	126
		PATH	12,322	4	2	4	101	12,733	4	3	4	104	13,041	4	3	4	106	13,349	4	3	4	109	13,349	4	3	4	109
		SYM	15,040	4	2	3	123	15,541	4	2	3	127	15,917	4	2	3	130	16,293	4	2	3	133	16,293	4	2	3	133

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		LAT Factor
0°C	32°F	1.06
5°C	41°F	1.05
10°C	50°F	1.04
15°C	59°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	0.96

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the **RADPT LED** platform 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.

Projected LED Lumen Maintenance				
	0	25,000	50,000	100,000
P1	1.00	0.96	0.91	0.82
P2	1.00	0.96	0.91	0.82
P3	1.00	0.96	0.91	0.82
P4	1.00	0.96	0.91	0.82
P5	1.00	0.95	0.89	0.78

Electrical Load

Lumen Package	LED Drive Current	Voltage	Wattage		Current (A)					
					120	208	240	277	347	480
P1	500	42.8	21.4	Input Current	0.22	0.13	0.11	0.1	0.08	0.06
				System Watts	26	26	26	27	25	26
P2	770	43	33.1	Input Current	0.33	0.19	0.16	0.14	0.11	0.08
				System Watts	39	39	39	39	38	38
P3	1100	43.2	47.5	Input Current	0.46	0.26	0.23	0.2	0.16	0.12
				System Watts	55	54	54	54	54	54
P4	900	87.3	78.6	Input Current	0.73	0.42	0.36	0.32	0.25	0.18
				System Watts	87	86	86	86	86	86
P5	1250	88.2	110.2	Input Current	1	0.58	0.5	0.44	0.35	0.25
				System Watts	120	119	119	119	120	120



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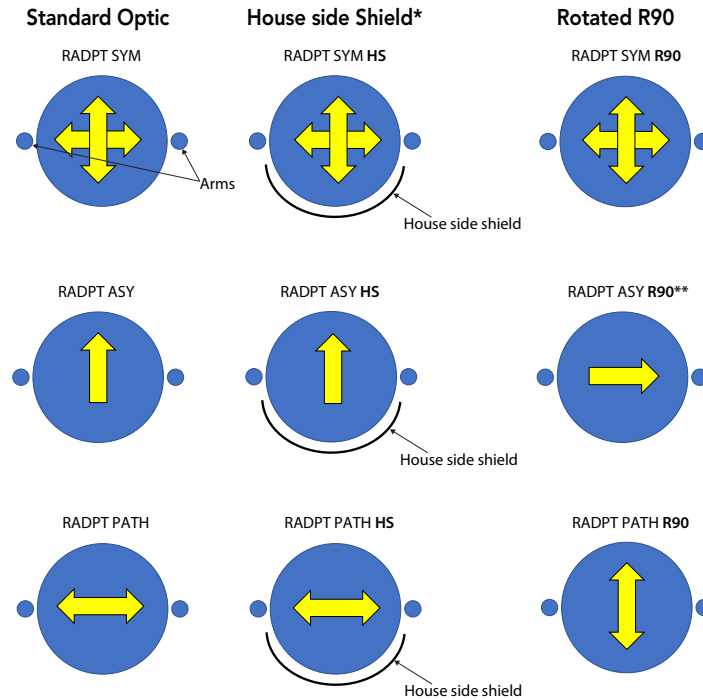
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RADPT LED
Rev. 11/14/24

Orientation Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's [RADPT LED homepage](#).

Isofootcandle plots are considered to be representative of available optical distributions.



*HS not available with R90

**For L90, use R90 and rotate luminaire 180° on pole

FEATURES & SPECIFICATIONS

INTENDED USE

Pedestrian areas such as parks, campuses, pathways, courtyards and pedestrians malls.

CONSTRUCTION

Single-piece die-cast aluminum housing with nominal wall thickness of 0.125" on a 6mm thick acrylic waveguide is fully gasketed with a single piece tubular silicone gasket.

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 and white. Available in textured and non-textured finishes.

OPTICS

6MM thick acrylic waveguide with 360° flexible LED board. Available in 2700K, 3000K, 3500K, 4000K and 5000K (80CRI) CCT configurations.

ELECTRICAL

Light engine consists of 96 high-efficacy LEDs mounted to a flexible circuit board and aluminum heat sink, ensuring optimal thermal management and long life. Fixtures ship standard with 0-10v dimming driver (order option DMG for connection to exterior controls). Class 1 electronic driver has a power factor >90%, THD <20%, and with an expected life of 100,000 hours with <1% failure rate. Serviceable 10kV surge protection device meets a minimum Category C Low for operation (per ANSI/IEEE C62.41.2).

INSTALLATION

Standard post-top PT4 type mounting configuration fits into a 4" OD open pole top (round pole only). Alternate tenon (2-3/8" or 2-7/8") mounting also available and require 4" tall tenons.

LISTINGS

CSA certified to U.S. and Canadian standards. Luminaire is IP65 rated. Rated for -40°C minimum ambient.

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/DQL 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 or less. U.S. Patent No. D925,088S

GOVERNMENT PROCUREMENT

BAA – Buy America(n) Act. Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA – Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.

Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY

5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

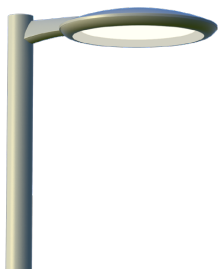
All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.



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Radean Arm Mount LED Area Luminaire



Specifications

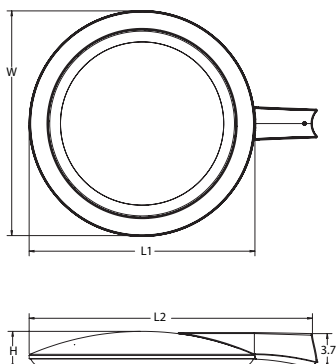
EPA: 0.75 ft²
(0.05 m²)

Length:
L1 24" (61cm)
L2 30" (60.96 cm)

Width: 24" (61cm)

Height: 4" (10.2cm)

Weight (max): 29lbs
(13.15Kg)



APPROVED ALTERNATE MANUFACTURERS:
1. PACIFICA "PLED" SERIES
2. COOPER INVUE "LXS LUXESCAPE" SERIES

Notes

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Hit the Tab key or mouse over the page to see all interactive elements.

Introduction

The RADEAN arm mount luminaire is the perfect choice for pedestrian applications where daytime aesthetics and visual comfort are needed. Adding architectural flair to any space, the RADEAN's low-profile shape and smooth curves blend in while adding a touch of elegance.

Perfect for campuses, parks, pedestrian malls, courtyards and pathways, the RADEAN arm mount is the Architect's choice to provide beautiful aesthetics both day and night.

Ordering Information

EXAMPLE: RAD1 LED P3 30K SYM MVOLT RPA PE DNAXD

RAD1 LED					
Series	Performance package	Color temperature	Distribution	Voltage	Mounting
RAD1 LED	P1 3,000 Lumens	27K 2700K	SYM Symmetric type V ASY Asymmetric type IV PATH Pathway type III	MVOLT ² 120 ² 277 ² 208 ² 347 240 ² 480	SPA Square pole mounting (includes adapter)
	P2 5,000 Lumens	30K 3000K			RPA Round pole mounting
	P3 7,000 Lumens	35K 3500K			WBA Wall bracket
	P4 11,000 Lumens	40K 4000K			
	P5 16,000 Lumens	50K 5000K			
Control options		Other options		Finish (required)	
Shipped installed		Shipped separately			
NLTAIR2	nLight AIR 2.0 enabled ³	SF Single Fuse ²	HS Houseside shield ⁵	DDBXD Dark bronze	DDBTXD Textured dark bronze
PE	Button photocell ³	DF Double Fuse ²		DBLXD Black	DBLTXD Textured black
FAO	Field adjustable output ³	L90 Left rotated optics		DNAXD Natural aluminum	DNATXD Textured natural aluminum
DMG	0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately)	R90 Right rotated optics		DWHXD White	DWHGXD Textured white

Accessories

Ordered and shipped separately.

RADHS Houseside shield (shield is white)
RADFBC Full base cover for 4" RSS pole (specify finish)

For more control options, visit [DTL](#) and [ROAM](#) online.

NOTES

- 2700K and 3500K may require extended lead-times.
- MVOLT driver operates on any line voltage from 120-277V (50/60 Hz). Single fuse (SF) requires 120, 277 or 347 voltage option. Double fuse (DF) requires 208, 240 or 480 voltage option.
- NLTAIR2 not available with PE or FAO. Must link to external nLight Air network. Does not include occupancy sensor. For more information refer to [rSBOR](#) pole mount sensor.
- DMG not available with NLTAIR2 or FAO.
- Also available as a separate accessory; see Accessories information. Shield is field rotatable in 45° increments.



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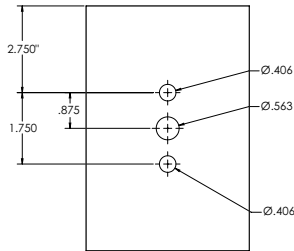
RAD1 LED
Rev. 11/14/24

Mounting

Recommended Poles for use with RADEAN RAD1 LED Luminaires.			
Acuity Part Number	Description	For luminaires:	Used with Mounting
RSS 10 4B DM19RAD DDBXD	10' Round Straight Steel - Template #20 Drilling	RAD1 LED	RPA
RSS 12 4B DM19RAD DDBXD	12' Round Straight Steel - Template #20 Drilling	RAD1 LED	RPA
RSS 14 4B DM19RAD DDBXD	14' Round Straight Steel - Template #20 Drilling	RAD1 LED	RPA
RSS 16 4B DM19RAD DDBXD	16' Round Straight Steel - Template #20 Drilling	RAD1 LED	RPA
RSS 18 4B DM19RAD DDBXD	18' Round Straight Steel - Template #20 Drilling	RAD1 LED	RPA
RSS 20 4B DM19RAD DDBXD	20' Round Straight Steel - Template #20 Drilling	RAD1 LED	RPA
RSS 25 4B DM19RAD DDBXD	25' Round Straight Steel - Template #20 Drilling	RAD1 LED	RPA
SSS 10 4C DM19RAD DDBXD	10' Square Straight Steel - Template #20 Drilling	RAD1 LED	SPA
SSS 12 4C DM19RAD DDBXD	12' Square Straight Steel - Template #20 Drilling	RAD1 LED	SPA
SSS 14 4C DM19RAD DDBXD	14' Square Straight Steel - Template #20 Drilling	RAD1 LED	SPA
SSS 16 4C DM19RAD DDBXD	16' Square Straight Steel - Template #20 Drilling	RAD1 LED	SPA
SSS 18 4C DM19RAD DDBXD	18' Square Straight Steel - Template #20 Drilling	RAD1 LED	SPA
SSS 20 4C DM19RAD DDBXD	20' Square Straight Steel - Template #20 Drilling	RAD1 LED	SPA
SSS 25 4C DM19RAD DDBXD	25' Square Straight Steel - Template #20 Drilling	RAD1 LED	SPA

* Customer must verify pole loading per required design criteria and specified wind speed. Consult pole specification sheet for additional details.

Drilling Template #20



RAD1 has a unique drilling pattern. Specify this drilling pattern when specifying poles, per the table below.

DM19RAD	Single unit	DM29RAD	2 at 90° ^{1,2}
DM28RAD	2 at 180°	DM39RAD	3 at 90° *
DM49RAD	4 at 90° ¹	DM32RAD	3 at 120°

Example: SSA 20 4C DM19RAD DDBXD

Visit Lithonia Lighting's [POLES CENTRAL](#) to see our wide selection of poles, accessories and educational tools.

1. Round pole top must be 4.25" O.D. minimum.
2. Square pole top must be 3.125" O.D. minimum.



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RAD1 LED
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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. Contact factory for performance data on any configurations not shown here.

Performance Package	Input Wattage	Distribution	2700K					3000K					3500K					4000K					5000K				
			Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P1	25	ASY	3,103	1	0	1	122	3,207	1	0	1	126	3,285	1	0	1	129	3,362	1	0	1	132	3,362	1	0	1	132
		PATH	2,695	2	0	2	106	2,785	2	0	2	110	2,853	2	0	2	112	2,920	2	0	2	115	2,920	2	0	2	115
		SYM	3,271	2	0	1	129	3,380	2	0	1	133	3,461	2	0	1	136	3,543	2	0	1	139	3,543	2	0	1	139
P2	38	ASY	4,798	1	0	2	126	4,958	1	0	2	130	5,078	2	0	2	134	5,198	2	0	2	137	5,198	2	0	2	137
		PATH	4,167	2	0	2	110	4,306	3	0	3	113	4,410	3	0	3	116	4,514	3	0	3	119	4,514	3	0	3	119
		SYM	5,056	2	0	1	133	5,225	3	0	1	137	5,351	3	0	1	141	5,478	3	0	1	144	5,478	3	0	1	144
P3	54	ASY	6,779	2	0	2	126	7,005	2	0	2	131	7,174	2	0	2	134	7,344	2	0	2	137	7,344	2	0	2	137
		PATH	5,887	3	0	3	110	6,084	3	0	3	113	6,231	3	0	3	116	6,378	3	0	3	119	6,378	3	0	3	119
		SYM	7,144	3	0	2	133	7,382	3	0	2	138	7,561	3	0	2	141	7,739	3	0	2	144	7,739	3	0	2	144
P4	86	ASY	10,773	3	0	3	126	11,132	3	0	3	130	11,401	3	0	3	133	11,671	3	0	3	136	11,671	3	0	3	136
		PATH	9,356	3	0	3	109	9,668	3	0	3	113	9,902	3	0	3	116	10,136	3	0	3	118	10,136	3	0	3	118
		SYM	11,353	3	0	2	133	11,731	3	0	2	137	12,015	3	0	2	140	12,299	3	0	2	144	12,299	3	0	2	144
P5	122	ASY	15,001	3	0	3	123	15,501	3	0	3	127	15,876	3	0	3	130	16,251	3	0	3	133	16,251	3	0	3	133
		PATH	13,028	4	0	4	107	13,462	4	0	4	110	13,788	4	0	4	113	14,114	4	0	4	116	14,114	4	0	4	116
		SYM	15,808	4	0	3	130	16,335	4	0	3	134	16,731	4	0	3	137	17,126	4	0	3	140	17,126	4	0	3	140

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		LAT Factor
0°C	32°F	1.06
5°C	41°F	1.05
10°C	50°F	1.04
15°C	59°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	0.96

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the **RAD1 LED P5** platform 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.

Projected LED Lumen Maintenance				
	0	25,000	50,000	100,000
P1	1.00	0.96	0.91	0.82
P2	1.00	0.96	0.91	0.82
P3	1.00	0.96	0.91	0.82
P4	1.00	0.96	0.91	0.82
P5	1.00	0.95	0.89	0.78

Electrical Load

Lumen Package	LED Drive Current	Voltage	Wattage		Current (A)					
					120	208	240	277	347	480
P1	500	42.8	21.4	Input Current	0.22	0.13	0.11	0.1	0.08	0.06
				System Watts	26	26	26	27	25	26
P2	770	43	33.1	Input Current	0.33	0.19	0.16	0.14	0.11	0.08
				System Watts	39	39	39	39	38	38
P3	1100	43.2	47.5	Input Current	0.46	0.26	0.23	0.2	0.16	0.12
				System Watts	55	54	54	54	54	54
P4	900	87.3	78.6	Input Current	0.73	0.42	0.36	0.32	0.25	0.18
				System Watts	87	86	86	86	86	86
P5	1250	88.2	110.2	Input Current	1	0.58	0.5	0.44	0.35	0.25
				System Watts	120	119	119	119	120	120



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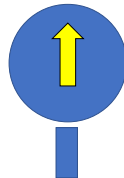
Orientation Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's [RAD1 LED homepage](#).

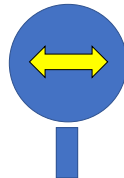
Standard Optic



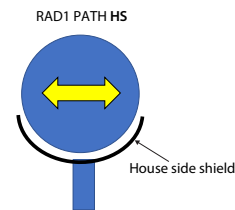
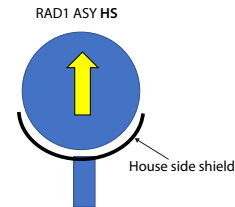
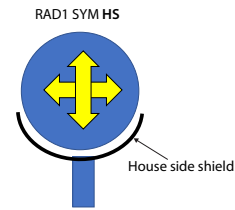
RAD1 ASY Standard



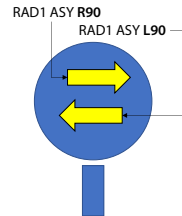
RAD1 PATH



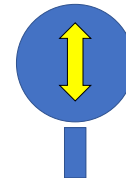
House side Shield



Rotated R90



RAD1 PATH R90



FEATURES & SPECIFICATIONS

INTENDED USE

Pedestrian areas such as parks, campuses, pathways, courtyards and pedestrians malls.

CONSTRUCTION

Single-piece die-cast aluminum housing with nominal wall thickness of 0.125" on a 6mm thick acrylic waveguide is fully gasketed with a single piece tubular silicone gasket.

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 and white. Available in textured and non-textured finishes.

OPTICS

6MM thick acrylic waveguide with 360° flexible LED board. Available in 2700K, 3000K, 3500K, 4000K and 5000K (80CRI) CCT configurations.

ELECTRICAL

Light engine consists of 96 high-efficacy LEDs mounted to a flexible circuit board and aluminum heat sink, ensuring optimal thermal management and long life. Fixtures ship standard with 0-10v dimming driver (order option DMG for connection to exterior controls). Class 1 electronic driver has a power factor >90%, THD <20%, with an expected life of 100,000 hours with <1% failure rate. Serviceable 10kV surge protection device meets a minimum Category C Low for operation (per ANSI/IEEE C62.41.2).

INSTALLATION

Included luminaire and integral arm facilitate quick and easy installation. Stainless steel bolts fasten the mounting block securely to poles and walls.

LISTINGS

CSA certified to U.S. and Canadian standards. Luminaire is IP65 rated. Rated for -40°C minimum ambient.

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 or less.

GOVERNMENT PROCUREMENT

BAA – Buy America(n) Act: Product qualifies as a domestic end product under the Buy American Act as implemented in the FAR and DFARS. Product also qualifies as manufactured in the United States under DOT Buy America regulations.

BABA – Build America Buy America: Product qualifies as produced in the United States under the definitions of the Build America, Buy America Act.

Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY

5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.



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RAD1 LED
Rev. 11/14/24

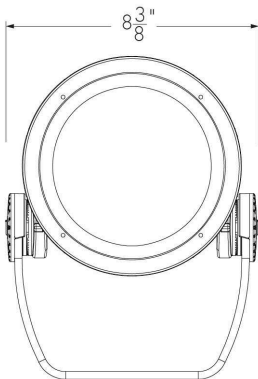
APPROVED ALTERNATE MANUFACTURERS:
1. INSIGHT "PROSPOT 6" SERIES
2. GVA "FL25-GEN2" SERIES

Project Name

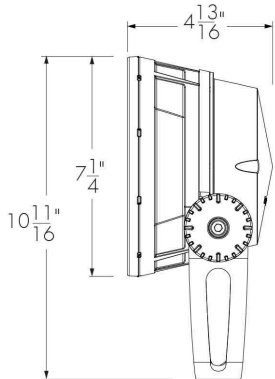
Type **OL3**

Catalog / Part Number

Qty



Front view



Side view

Photometric Summary

Symmetric

	Delivered output (lm)	Intensity (peak cd)
XN (3°)	2,381	331,811
VN (6°)	1,888	99,894
NS (10°)	2,714	38,895
NF (20°)	2,567	24,613
M (30°)	2,490	13,855
FL (40°)	2,252	5,837
WFL (60°)	2,020	1,520

Asymmetric

NAS	1,726	28,602 (@2.5°)
WW	2,363	3,940 (@5°)

Based on 4000K configuration.
Photometric performance is measured externally in compliance with IESNA LM-79-24.
Refer to Photometric Guide on Lumenpulse website for information on other color temperatures.

Description

The Lumenbeam Medium is an IP66-rated luminaire for lighting landscapes, trees, columns, monuments, and architectural details. It has numerous options, including optics for flood or accent lighting, a choice of color temperatures and colors, as well as various accessories, spread lenses, and controls. The luminaire also has an anti-corrosion option for use in harsh, chemical, or coastal environments.

Features

Color and Color Temperature	22K: 2200K, 27K: 2700K, 30K: 3000K, 35K: 3500K, 40K: 4000K, 57K: 5700K, RD: Red, GR: Green, BL: Blue
Optics (Nominal Distribution)	XN: Extra Narrow 3°, VN: VN (6°), NS: NS (10°), NF: NF (20°), M: M (30°), FL: FL (40°), WFL: WFL (60°), VWFL: VWFL (90°), NAS: NAS (Narrow Asymmetric), WW: WW (Asymmetric Wallwash)
Optical Option	LSLH: Linear Spread Lens Horizontal Distribution, LSLV: Linear Spread Lens Vertical Distribution
Option	SY: Short Yoke, SRY: Short Rotational Yoke, RY: Rotational Yoke, 3GV: 3G ANSI C136.31-2010 Vibration Rating for Bridge Applications, CRC: Corrosion-Resistant Coating for Hostile Environments
Cable Color	BK: Black, WH: White
Power Consumption	28 W
Warranty	5-year limited warranty

Performance

Maximum Delivered Output	2,714 lm (4000K, NS 10°)
Maximum Delivered Intensity	331,811 cd at nadir (4000K, XN 3°)
Illuminance at Distance	Minimum 1 fc at 578 ft (4000K, XN 3°)
Color Consistency	3 SDCM

How to Order

Housing	Voltage	Color and Color Temperature (1)	Optic	Optical Option (7) (9)	Finish	Control (13) (14)	Option	Certification	Cable Length (14) (21)	Cable Color	Buy American Act
LBM Lumenbeam™ Medium	100 100 Volts 120 120 Volts 208 208 Volts 220 220 Volts 240 240 Volts 277 277 Volts	22K 2200K 27K 2700K 30K 3000K 35K 3500K 40K 4000K 57K 5700K RD Red (2) (3) GR Green (2) (3) BL Blue (2) (3)	XN Extra Narrow 3° (4) VN Very Narrow 6° (4) NS Narrow Spot 10° (4) NF Narrow Flood 20° (4) M Medium 30° (4) FL Flood 40° (4) WFL Wide Flood 60° (4) (5) VWFL Very Wide Flood 90° (4) (6) NAS Narrow Asymmetric (4) WW Asymmetric Wallwash (4)	LSLH Linear Spread Lens Horizontal Distribution (8) LSLV Linear Spread Lens Vertical Distribution (8)	BK Black Sandtex® BRZ Bronze Sandtex® SI Silver Sandtex® WH Smooth White BKTX Textured Black BRZTX Textured Bronze Non- Metallic GRATX Textured Medium Gray GRNTX Textured Green WHTX Textured White CC Custom Color & Finish (10) (11) (12)	NO On/Off Control DIM 0-10V Dimming DALI DALI Dimming DMX/RDM DMX/RDM Enabled (15) (16)	SY Short Yoke SRY Short Rotational Yoke (17) RY Rotational Yoke (17) 3GV 3G ANSI C136.31- 2010 Vibration Rating for Bridge Applications CRC Corrosion- Resistant Coating (18) (19)	UL UL Compliant CE CE Compliant (20) CEII CE Compliant Class II Double Insulated (20)	3FT 3 ft (14) (21) 10FT 10 ft 20FT 20 ft 30FT 30 ft 50FT 50 ft 70FT 70 ft 100FT 100 ft	BK Black WH White (22)	BAA Buy American (22) (23)

Notes:

1. Consult factory for availability of static Royal Blue, Amber, 6500K and 90+ CRI.

2. Static colors made to order 8-10 weeks.

3. Not available for XN optic.

4. Factory installed, not interchangeable on site.

5. A dome lens accessory is available, order separately. For compatibility, a WFL optic must be specified for the fixture.

6. Consult factory for photometric performance.

7. Optical options are factory installed and cannot be changed in the field.

8. Field adjustable spread lens optical accessory available, order separately.

9. Not available with WFL, VWFL, NAS and WW optics.

10. Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.

11. Setup charges apply for RAL colors. Consult factory for details.

12. Longer lead times can be expected for custom RAL color finishes.

13. Lumentalk system is enabled with LDB accessory. DIM or DMX/RDM must be specified in the order code. See the typical wiring diagrams in the specification sheet for details.

14. A Lumentranslator 2 (LT2) and LumentalkID (LIDLT) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.

15. A control box (CBX) and LumenID (LID) must be specified.

16. Maximum of 3 ft cable length for daisy chain DMX applications with CBX-DS.

17. Consult factory for applications with 3GV requirements.

18. Use only when exposed to salt spray. This option is not required for normal outdoor exposure.

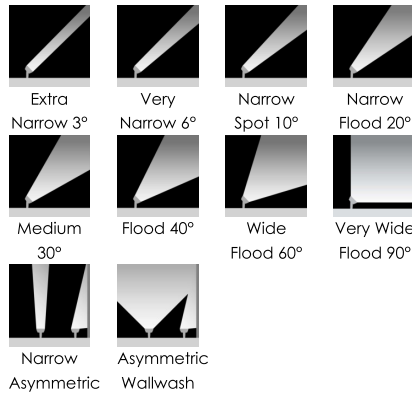
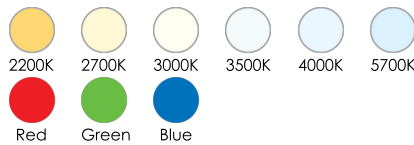
19. Setup charges apply. Consult factory for details.

20. Consult European specification sheets and installation instructions for CE and CE Class II wiring information.

21. 3 ft cable length is standard unless otherwise specified.

22. Not available with CE or CEII certification options.

23. Contact your Lumenpulse Sales Representative for more information on order volume details.

Optic**Color and Color Temperature****Control****Ratings**

IP66 IK09

Certifications**Color Rendering**

Minimum CRI 80

Lumen Maintenance

L70 > 250,000 hrs (Ta 25 °C) (> 80,000 hrs for XN 3°, VN 6°, NAS optics only)

Physical**Housing Material**

Low copper content high pressure die-cast aluminum

Yoke Material

Heavy aluminum (standard yoke included)

Lens Material

Clear tempered glass

Hardware Material

Stainless steel

Gasket Material

Silicone

Surface Finish

Electrostatically applied polyester powder coat

Weight

6.7 lbs

EPA

Front = 0.44 ft², Side = 0.18 ft²

Electrical and Control**Voltage**

100 to 277 volts

Fixture Cable

Power and data in one cable

Conductors

3C #16-3 (NO control), 5C #16-5 (DIM, DALI control), 6C #14-3/#24-3 (DMX/RDM control)

Control

On/Off Control, 0-10V Dimming, DALI Dimming, DMX/RDM Enabled, Lumentalk system is enabled with LDB accessory - see typical wiring diagrams for details

Resolution (DMX/RDM)

Per fixture, 8-bit or 16-bit

Environmental**Storage Temperature**

-40 °F to 158 °F (device must reach start-up temperature value before operating)

Start-up Temperature

-13 °F to 122 °F

Operating Temperature

-40 °F to 122 °F

Ingress Protection Rating

IP66, Wet location rated

Impact Resistance Rating

IK09

Application Wind Speed

Luminaires were designed based on AASHTO 2013 standard to ensure highest quality and safety. Installation should be validated by a local project engineer to ensure the luminaires are suitable for the wind speed and exposure of the specific application

Accessories (Order Separately)**Optical Accessories**

Lumenbeam Medium Snoot, Lumenbeam Medium Snoot Wide, Lumenbeam Medium Visor, Lumenbeam Medium Linear Spread Lens Adjustable, Lumenbeam Medium Wire Guard, Lumenbeam Medium Dome Lens

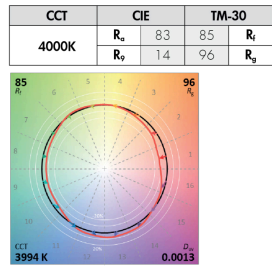
Control Boxes

DMX/RDM enabled (Daisy Chain or Star Configuration), Ethernet enabled (Daisy Chain or Star Configuration), Lumentalk Data Bridge

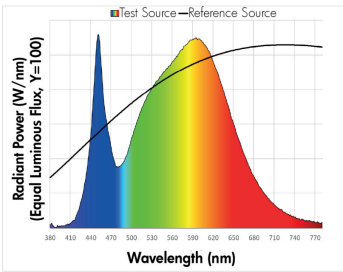
Control Systems	Lumenscene™ (LSC), Pharos® Lighting Control Kit (PHAROS)
Diagnostic and Addressing Tools	LumenID (LID)

Chromaticity Data

TM-30 - 4000K

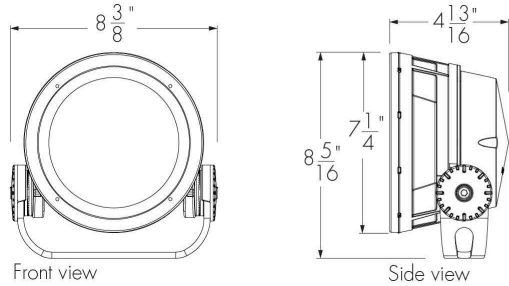


Spectral Power Distribution

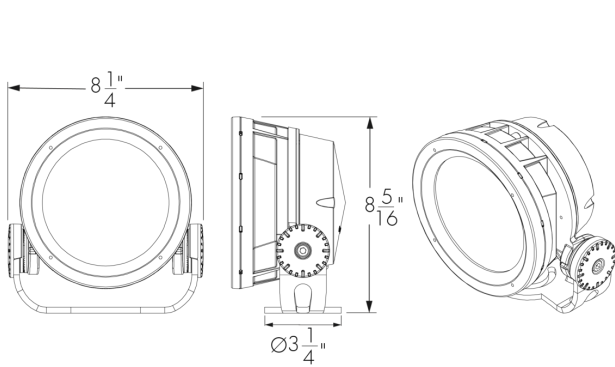


Mounting Options

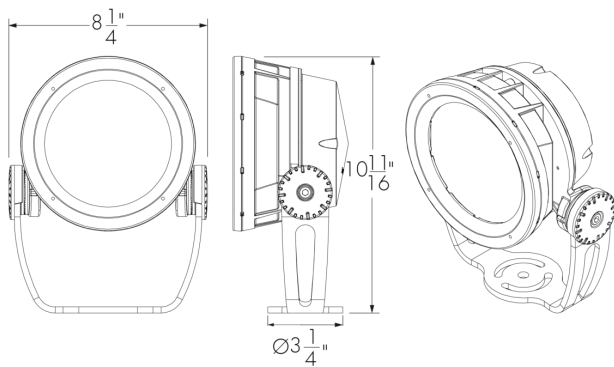
SY - Short Yoke



SRY - Short Rotational Yoke

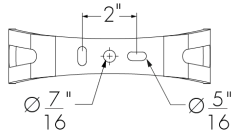


RY - Rotational Yoke



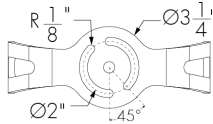
Mounting Details

Mounting Hole Pattern - Standard And Short Yoke



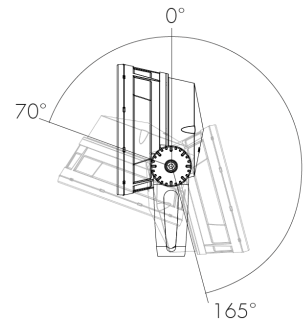
3 bolts are required for wind and vibration resistance, provided by others.

Mounting Hole Pattern - Rotational Yoke

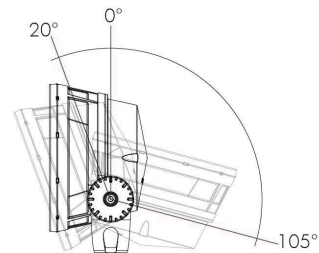


3 bolts are required for wind and vibration resistance, provided by others.

Adjustable Pivot Limits



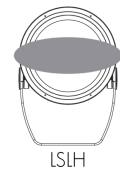
Standard Yoke



Short Yoke

Optical Options

LSLH - Linear Spread Lens Horizontal Distribution



LSLH - Linear spread lens horizontal distribution

LSLV - Linear Spread Lens Vertical Distribution



Beam Angles

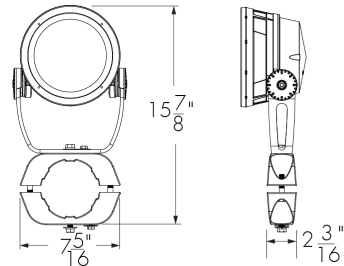
Optic installed in fixture	Beam angle with LSLH/LSLV
XN	5° x 60°
VN	7° x 60°
NS	13° x 66°
NF	16° x 62°
M	23° x 65°
FL	33° x 70°

LLF: 0.88*
*LLF may vary slightly by distribution chosen.

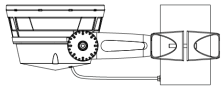
Factory installed, not adjustable on site. Not available for WFL, VWFL, NAS and WW optics.
See 'Optical Accessories' section for field adjustable spread lens (LSLA).

Mounting Accessories (Order Separately)

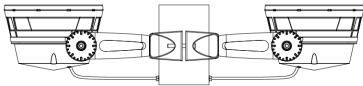
Round Pole Mounting Accessory



PM4 model shown.
Consult factory for square pole section.



PM4-1, PM4.5-1, PM5-1 - Round pole mounting accessory - single fixture



PM4-2, PM4.5-2, PM5-2 - Round pole mounting accessory - twin fixtures
*One bracket assembly is supplied per 2 fixtures unless otherwise specified.

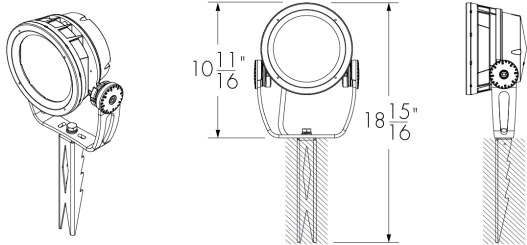
	PM4	PM4.5	PM5
For pole Ø	4" ± 1/16"	4.5" ± 1/16"	5" ± 1/16"

Consult factory for other pole diameters.

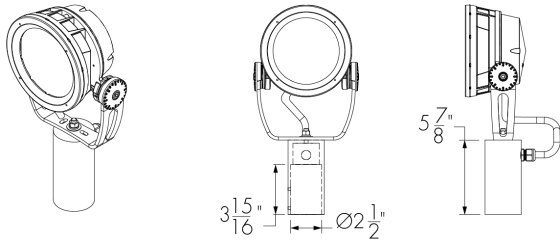
PLTU - Universal Yoke

Refer to the Universal Yoke specification sheet and Pole installation instructions for more details. Square Lumentech profile shown. The mounting holes used for this fixture are shown in gray.

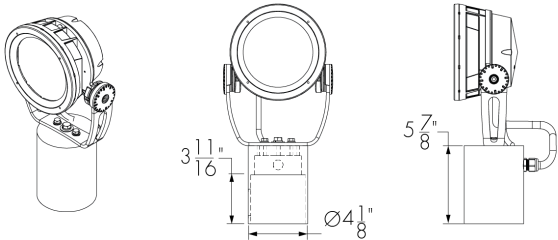
SK - Stake Mounting



Tenon Adapter



TN2 - Tenon adapter to fit on 2 3/8 in O.D. tenon
Vertical mounting only. Consult factory for horizontal mounting.

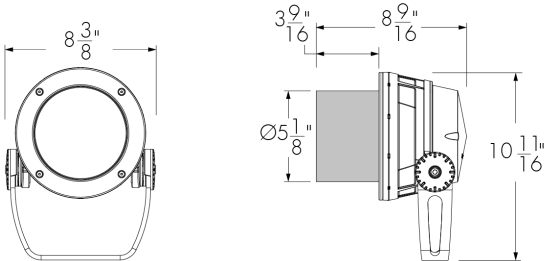


TN4 - Tenon adapter to fit on 4 in O.D. tenon
Vertical mounting only. Consult factory for horizontal mounting.

Optical Accessories (Order Separately)

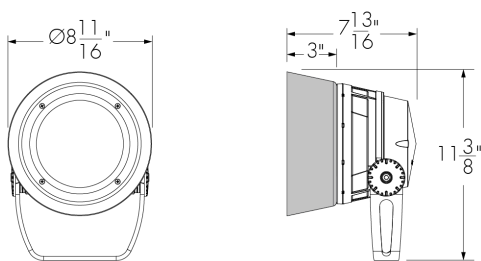
Installed optical accessories will affect the maximum pivot limits for each mounting option, consult factory for details.

SN - Snoot



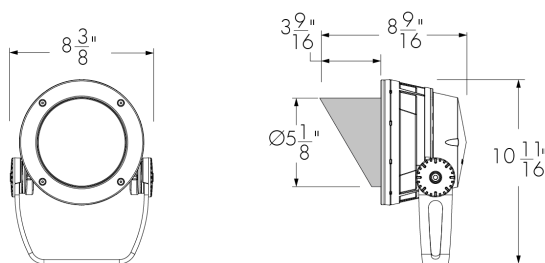
LBMSN-FINISH-BK-OPTIONS (CRC)
Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

SNW - Snoot Wide



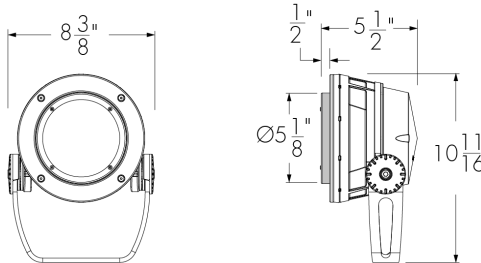
LBMSNW-FINISH-BK-OPTIONS (CRC)
Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

VS - Visor



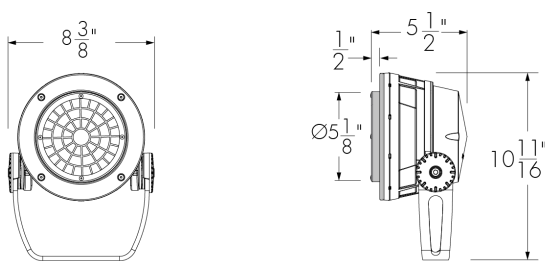
LBMVS-FINISH-BK-OPTIONS (CRC)
Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

LSLA - Linear Spread Lens Adjustable



LBMLSLA-FINISH-OPTIONS (CRC)
Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

WG - Wire Guard



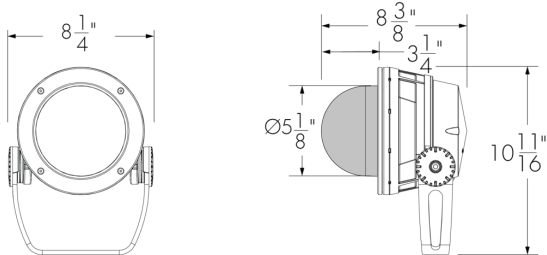
LBMWG-FINISH-OPTIONS (CRC)
Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

Accessory Combinations

	+	Snoot	Snoot wide	Visor
Linear spread lens adjustable		LBMSNLSLA	N/A *	LBMVLSLA
Wire guard		LBMSNWWG	N/A	LBMVSWG

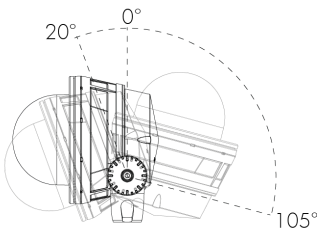
Accessory combinations must be ordered together on a single line.
Ex: A snoot + wire guard combination order code is LBMSNWWG-FINISH-BK-OPTIONS. A maximum of two accessories can be combined per fixture.
*Consult factory for a linear spread lens adjustable + snoot wide combination.

DM - Dome Lens

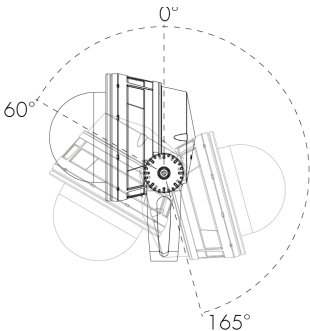


LBMDM-FINISH-OPTIONS (CRC)
Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

Dome - Short Yoke - Pivot limits



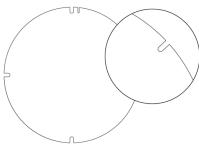
Dome - Standard Yoke - Pivot limits



Dome Lens is available with WFL Optic only. The WFL optic must be specified for the fixture.
Dome Lens cannot be combined with other optical accessories.
Dome Lens will affect beam distribution. Consult factory for application support and photometric performance.

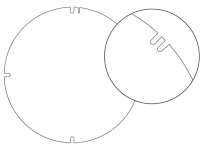
Diffuser Lenses (Intended for Mockup Purposes Only, Order Separately)

Diffuser Lens 1 (1 Notch)



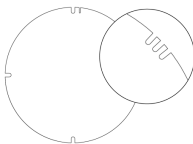
147671

Diffuser Lens 2 (2 Notches)



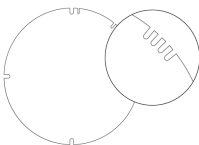
147672

Diffuser Lens 3 (3 Notches)



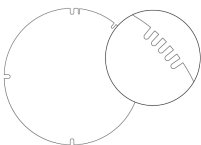
147673

Diffuser Lens 4 (4 Notches)



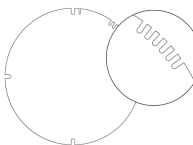
147674

Diffuser Lens 5 (5 Notches)



147675

Diffuser Lens 6 (6 Notches)



147676

Final Distribution Using Diffuser Lenses

Original Distribution on Fixture	Final Distribution Using Diffuser Lens					
	Diffuser Lens 1 1 Notch	Diffuser Lens 2 2 Notches	Diffuser Lens 3 3 Notches	Diffuser Lens 4 4 Notches	Diffuser Lens 5 5 Notches	Diffuser Lens 6 6 Notches
XN (4°/5°)	VN	NS				
VN (6°)	NS		NF	M	FL	WFL
NS (10°)						
NF (20°)						
M (30°)				FL	WFL	
FL (40°)						
WFL (60°)						VWFL
VWFL (90°)						

Choose a diffuser lens based on the desired final beam distribution. Refer to the 6-digit part numbers above to order diffuser lenses individually. To order a complete set of 6 diffuser lenses in a bag, refer to the following item names: **LBS**: LBALK-S **LBM/LBMP**: LBALK-M **LBL/LBLP**: LBALK-L **LBG/LBGP**: LBALK-G **LBX/LBXP**: LBALK-X.

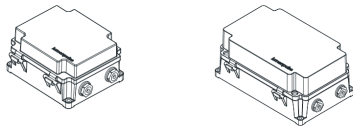
The diffuser lenses are intended for mockup purposes only. A lens holder is required to install a diffuser lens on the fixture, order separately using the following names: **LBS**: LBSLSLA-FINISH-LBALK **LBM/LBMP**: LBMLSLA-FINISH-LBALK **LBL/LBLP**: LBLLSLA-FINISH-LBALK **LBG/LBGP**: LBGLSLA-FINISH-LBALK **LBX/LBXP**: LBXLSLA-FINISH-LBALK

Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

Refer to the Diffuser Lens Installation Instructions on the Lumenpulse website for information on installing the diffuser lenses.

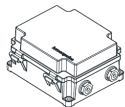
Control Boxes (Order Separately)

CBX-DMX/RDM - DMX/RDM Enabled (Daisy Chain or Star Configuration)



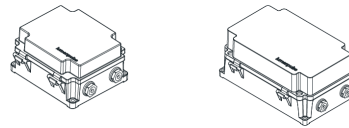
DMX/RDM control box. Up to six power and data outputs to fixtures or fixture runs. Consult CBX specification sheet and installation instructions for details. Lumenterminators provided with CBX (2x for daisy chain configuration, 6x for star configuration), consult factory to order spares.

LDB - Lumentalk Data Bridge



Lumentalk Data Bridge, 0-10V or DMX output. Consult LDB specification sheet for details.

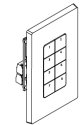
CBX-ENET - Ethernet Enabled (Daisy Chain or Star Configuration)



Ethernet control box. Up to four power and data outputs to fixture or fixture runs. Consult Ethernet CBX specification sheet and installation instructions for details.

Control Systems (Order Separately)

Lumenscene



The Lumenscene, a user-friendly DMX/RDM lighting controller that includes eight preconfigured scene changes and can be programmed via RDM.

PHAROS - Pharos® Kit



The Pharos kit, available for 1 or 2 DMX universes, allows for complete control of large lighting installations. 2 DMX universes kit shown.

Diagnostic And Addressing Tools (Order Separately)

LID - LumenID



LumenID is a diagnostic and addressing DMX/RDM tool. It must be specified on all DMX applications. Consult LID specification sheet for details.

EPA Guide

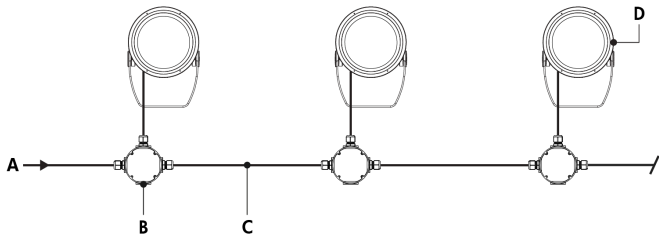
	LBM	LBM with Snoot	LBM with Visor	LBM with Snoot Wide	LBM with Dome Lens
EPA front (sq ft)	0.437	0.437	0.437	0.578	0.437
EPA side (sq ft)	0.178	0.317	0.317	0.301	0.083

Typical Wiring Diagrams

Wiring Color Code

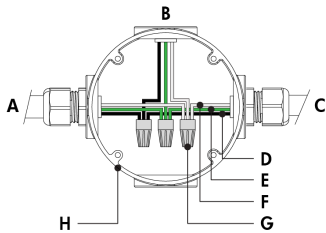
UL Color Code	USE
Green	Ground
Black	Line
White	Line/Neutral
Red or Purple	0-10V / Data +
Orange	0-10V / Data -
Gray	Signal common (DMX/RDM only)

On/Off Control (NO)



- A - Power input (100-277V AC, wiring by others)
- B - Junction box (by others)
- C - Power wiring (by others)
- D - Lumenbeam Medium

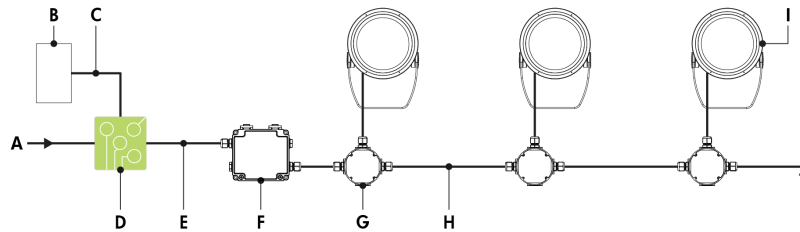
On/Off Control (NO) - Wiring Detail



- A - Power input or from previous fixture
- B - To fixture
- C - To next fixture
- D - Line
- E - Ground
- F - Line/Neutral
- G - Wire-nut (by others)
- H - Junction box (by others)

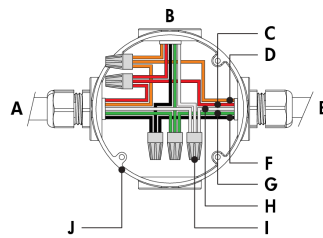
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- 28 watts per fixture.

Lumentalk (LT)



- A** - Power input (100-277V AC, wiring by others)
- B** - Dimmer/controller (order separately from Lumenpulse, or by others)
- C** - Data wiring (by others)
- D** - Lumentranslator 2 (LTL2-DIM, -DMX, -TRIAC, -DALI)
- E** - Power wiring (by others)
- F** - Lumentalk Data Bridge (LDB-DIM or LDB-DMX)
- G** - Junction box (by others)
- H** - Power and data wiring (by others)
- I** - Lumenbeam Medium

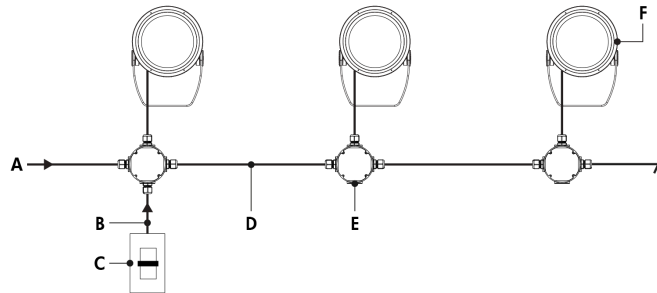
Lumentalk (LT) - Wiring Detail Using LDB



- A** - From Lumentalk Data Bridge (control over power line via Lumentalk system) or from previous fixture
- B** - To fixture
- C** - 0-10 V + / Data +
- D** - 0-10 V - / Data -
- E** - To next fixture
- F** - Line
- G** - Ground
- H** - Line/Neutral
- I** - Wire-nut (by others)
- J** - Junction box (by others)

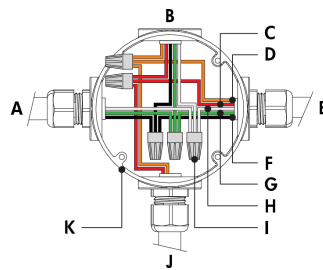
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Lumentalk Data Bridge required for Lumentalk system, see LDB installation instructions for details.
- For applications with all fixtures controlled as 1 zone: fixtures and Lumentalk Data Bridge must be specified as DIM. Maximum of 10 fixtures per LDB-DIM, consult factory for applications that require additional capabilities.
- For applications with fixtures controlled individually: fixtures and Lumentalk Data Bridge must be specified as DMX, 2-step commissioning process: 1 - DMX/RDM system using LumenID software and a LID, 2 - Lumentalk system using LumentalkID software and a LID-LT. Maximum of 32 fixtures per LDB-DMX. Consult factory for details.
- For DMX applications: 1 DMX controller per Lumentalk network, maximum of 48 DMX channels per Lumentalk network (minimum step transition update rate is 1 second, minimum fade time between two colors is 1 minute). Consult factory for applications that require additional capabilities.
- Maximum of 1 transmitter (Lumentranslator or Lumenlink) per system.
- No third party fixtures allowed on the same circuit.
- Consult factory for DALI Lumentalk applications.
- 1% minimum dimming value.
- 28 watts per fixture.

0-10V Dimming (DIM)



- A** - Power input (100-277V AC, wiring by others)
B - Data wiring (by others)
C - Dimmer (by others)
D - Power and data wiring (by others)
E - Junction box (by others)
F - Lumenbeam Medium

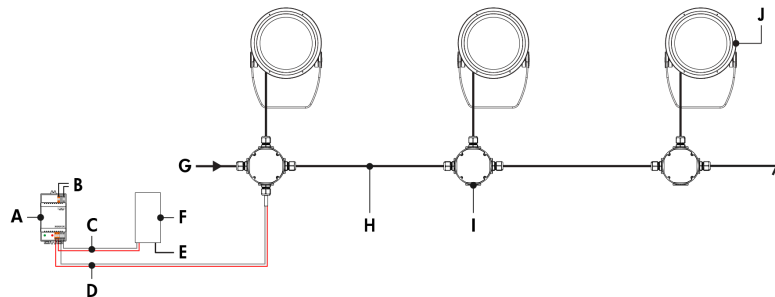
0-10V Dimming (DIM) - Wiring Detail



- A** - Power input or from previous fixture
B - To fixture
C - 0-10 V +
D - 0-10 V -
E - To next fixture
F - Line
G - Ground
H - Neutral
I - Wire-nut (by others)
J - From dimmer (by others)
K - Junction box (by others)

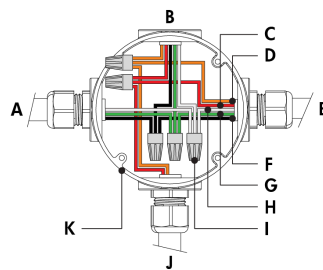
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- 0-10V mA ratings: passive dimmer (Current Sink): 3mA per fixture, active dimmer (Current Source): 0.5mA per fixture.
- 1% minimum dimming value.
- 28 watts per fixture.

DALI Dimming (DALI)



- A - DALI bus power supply (by others)
- B - Power input for DALI bus power supply (wiring by others)
- C - Data output to DALI controller (wiring by others)
- D - Data output to fixture (wiring by others)
- E - Power input for DALI controller (if required, wiring by others)
- F - DALI controller (by others)
- G - Power input (100-277V AC, wiring by others)
- H - Power and data wiring (by others)
- I - Junction box (by others)
- J - Lumenbeam Medium

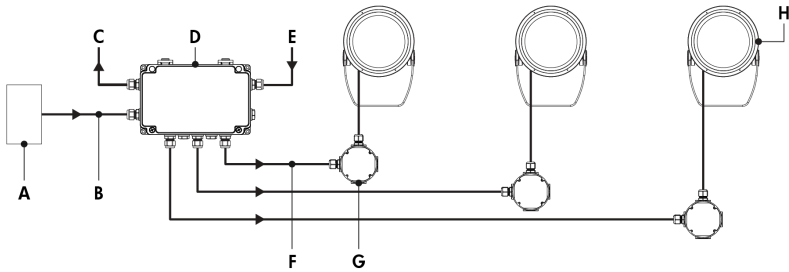
DALI Dimming (DALI) - Wiring Detail



- A - Power input or from previous fixture
- B - To fixture
- C - DA +
- D - DA -
- E - To next fixture
- F - Line
- G - Ground
- H - Neutral
- I - Wire-nut (by others)
- J - From DALI controller (by others)
- K - Junction box (by others)

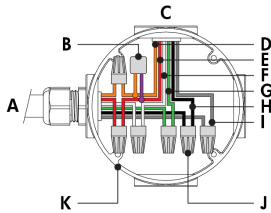
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Maximum of 64 DALI fixtures per DALI loop.
- Commissioning may be required based on the selection of 3rd party DALI controller. Controller and commissioning provided by others.
- 1% minimum dimming value.
- 28 watts per fixture.

Star Layout (DMX/RDM)



- A - DMX/RDM controller (order separately from Lumenpulse, or by others)
- B - Data input (Belden 9841 or equivalent, by others)
- C - Data output to next CBX (optional, not isolated/not boosted)
- D - CBX-ST
- E - Power input (100-277V AC, wiring by others)
- F - Power and data output to fixture (wiring by others)
- G - Junction box (by others)
- H - Lumenbeam Medium

Star Layout (DMX/RDM) - Wiring Detail



- A - From CBX
- B - Lumenterminator
- C - To fixture
- D - Data -
- E - Data +
- F - Neutral
- G - Ground
- H - Line
- I - Signal common
- J - Wire-nut (by others)
- K - Junction box (by others)

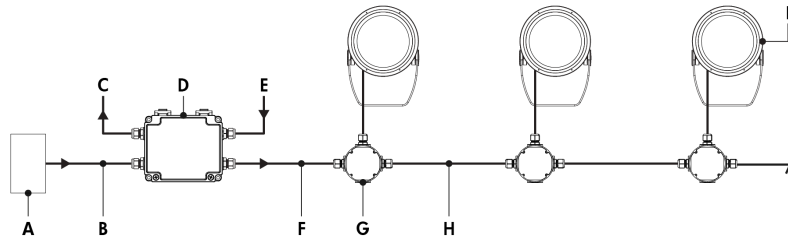
Maximum Fixture Count Per Run

Configuration/Voltage	120V	208V	240V	277V
LBM	29	32	32	32

Based on 15A maximum, 16AWG cable, fixtures spaced 10 ft on center, first fixture 50 ft from CBX.

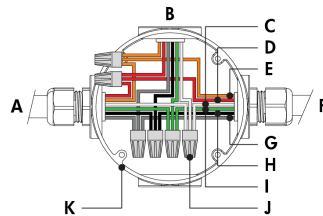
- Consult CBX installation instructions for additional wiring details.
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- The DMX/RDM protocol states a maximum of 32 DMX/RDM enabled fixtures on any single run.
- Maximum of 4 DMX/RDM repeaters/CBX cascading in line.
- Maximum of 6 outputs per CBX-ST.
- Each fixture requires 1 DMX address.
- DMX terminator is required at the end of each run to maintain data integrity. Six (6x) DMX lumenterminators included per CBX-ST. See installation instructions for details.
- 1% minimum dimming value.
- 28 watts per fixture.

Daisy Chain Layout (DMX/RDM)



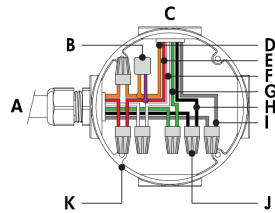
- A** - DMX/RDM controller (order separately from Lumenpulse, or by others)
B - Data input (Belden 9841 or equivalent, by others)
C - Data output to next CBX (optional, not isolated/not boosted)
D - CBX-DS
E - Power input (100-277V AC, wiring by others)
F - Power and data output to fixture (wiring by others)
G - Junction box (by others)
H - Power and data wiring (by others)
I - Lumenbeam Medium

Daisy Chain Layout (DMX/RDM) - Wiring Detail (First or Middle of Run)



- A** - From CBX or previous fixture
B - To fixture
C - Neutral
D - Data +
E - Data -
F - To next fixture
G - Signal common
H - Line
I - Ground
J - Wire-nut (by others)
K - Junction box (by others)

Daisy Chain Layout (DMX/RDM) - Wiring Detail (End of Run)



- A** - From CBX or previous fixture
B - Lumenterminator
C - To fixture
D - Data -
E - Data +
F - Neutral
G - Ground
H - Line
I - Signal common
J - Wire-nut (by others)
K - Junction box (by others)

Maximum Fixture Count Per Run

Configuration/Voltage	120V	208V	240V	277V
LBM	29	32	32	32

Based on 15A maximum, 16AWG cable, fixtures spaced 10 ft on center, first fixture 50 ft from CBX.

- Consult CBX installation instructions for additional wiring details.
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- The DMX/RDM protocol states a maximum of 32 DMX/RDM enabled fixtures on any single run.
- Maximum of 4 DMX/RDM repeaters/CBX cascading in line.
- Maximum of 1 output per CBX-DS.
- Maximum of 3 ft cable length between fixture and next junction box for daisy chain layout.
- Each fixture requires 1 DMX address.
- DMX terminator is required at the end of each run to maintain data integrity. Two (2x) DMX lumenterminators included per CBX-DS. See installation instructions for details.
- 1% minimum dimming value.
- 28 watts per fixture.