PROJECT MANUAL

Volume 1 of 3: Divisions 00 - 01
Volume 2 of 3: Divisions 02 - 14
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ADAMS COUNTY FLEET AND PUBLIC WORKS FACILITY

4955 E. 74th Ave.
Commerce City, CO 80022

100% Construction Documents For GMP Project Manual
September 30, 2019

1050 17th Street; Ste. A-200
Denver, CO 80265
Project No.: 4166-01
SECTION 00 01 07 - SEALS PAGE

DESIGN PROFESSIONALS OF RECORD

Architect: Stantec Architecture Inc. [STN].
License #_.

Responsible for Divisions 01-49 Sections except where indicated as prepared by other design professionals of record.

Civil Engineer: Huitt-Zollars [HZ]

Responsible for those Sections appended with "[HZ]" on Table of Contents.

Landscape Architect: Stantec Architecture Inc. [STN]
License #_.

Responsible for those Sections appended with "[STN]" on Table of Contents.
Structural Engineer: Monroe & Newell Engineers Inc. [MN]
License 
Responsible for those Sections appended with "[MN]" on Table of Contents.

Fire-Protection Engineer: MEP Engineering Inc. [MEP]
License 
Responsible for those Sections appended with "[MEP]" on Table of Contents.

Plumbing Engineer: MEP Engineering Inc. [MEP]
License 
Responsible for those Sections appended with "[MEP]" on Table of Contents.

HVAC Engineer: MEP Engineering Inc. [MEP]
License 
Responsible for those Sections appended with "[MEP]" on Table of Contents.
Electrical Engineer: MEP Engineering Inc. [MEP]
License #.
Responsible for those Sections appended with "[MEP]" on Table of Contents.

Lighting Designer: Stantec Architecture Inc. [STN]
License #.
Responsible for those Sections appended with "[STN]" on Table of Contents.

Vehicle Maintenance Equipment Consultant:
Maintenance Design Group now HDR Inc. [HDR]
License #.
Responsible for those Sections appended with "[HDR]" on Table of Contents.
Roofing Consultant: RoofTech Consultants Inc. [RC]
License #_.
Responsible for those Sections appended with "[RC]" on Table of Contents.

END OF SECTION 00 01 07
SECTION 00 01 09 - PROJECT DIRECTORY

PART 1 - HIDDEN LINE - DO NOT REMOVE

1.01 PROJECT TEAM

A. Owner:

1. Adams County [AC].
2. 4430 S. Adams County Parkway.
3. 1st Floor, Suite C1700.
5. Primary Contact(s):

   a. Carlson, Ranette.
6. Phone: 720-331-2403.
7. Email: rcarlson@adcogov.org.

B. Architect:

1. Stantec Architecture Inc. (RNL, now part of Stantec) [STN].
2. 1050 17th Street, Ste. A-200.
3. Denver, CO 80265.
4. Primary Contact(s):

   a. Flager, Jonathan.
5. Phone: 303-295-1717.
6. Fax: 303-292-0845.
7. Email: jonathan.flager@stantec.com.

C. Civil Engineer:

1. Huitt-Zollars [HZ].
2. 4582 South Ulster St.
5. Primary Contact(s):

   a. Peisley, Jeff.
6. Phone: 303-740-7325.
7. Email: jpeisley@Huitt-Zollars.com.

D. Landscape Architect:
1. Stantec Architecture Inc. (RNL, now part of Stantec) [STN].
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3. Denver, CO  80265.
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5. Phone: 303-575-8487.
6. Email: jeff.mckelvey@stantec.com.

E. Structural Engineer:

1. Monroe & Newell Engineers Inc. [HZ].
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4. Denver, CO 80202.
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   b. Rittenhouse, Jesse.
7. Email: jrittenhouse@monroe-newell.com.

F. Fire-Protection Engineer:

1. MEP Engineering Inc. [MEP].
2. 6402 S. Troy Circle.
3. Suite 100.
5. Primary Contact(s):
   a. Stutz, Russel.
6. Phone: 303-936-1633.
7. Email: russel@mep-eng.com.

G. Plumbing Engineer:

1. MEP Engineering Inc. [MEP].
2. 6402 S. Troy Circle.
3. Suite 100.
5. Primary Contact(s):
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6. Phone: 303-936-1633.
7. Email: russel@mep-eng.com.
H. HVAC Engineer:
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   5. Primary Contact(s):
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   6. Phone: 303-936-1633.
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I. Electrical Engineer:
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   7. Email: nick@mep-eng.com.

J. Lighting Design Consultant:
   1. Stantec Architecture Inc. (RNL, now part of Stantec) [STN].
   2. 1050 17th Street, Ste. A-200.
   3. Denver, CO 80265.
   4. Primary Contact(s):
      a. Stein, Dixon.
   5. Phone: 303-575-8455.
   6. Email: dixon.stein@stantec.com.

K. Vehicle Maintenance Equipment Consultant:
   1. Maintenance Design Group now HDR Inc. [HDR].
   2. 1670 Broadway.
   4. Denver, CO 80202-4824.
   5. Primary Contacts:
      a. Booth, Ken.
      b. Kraegel, Justin.
   6. Phone: 303-524-8406.
7. Email: justin.kraegel@hdrinc.com.

L. Roofing Consultant:

1. RoofTech Consultants Inc. [RC].
2. 14828 West 6th Ave Frontage Rd.
4. Primary Contact(s):
   a. Scott, Ronald.

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6. Email: ron@rooftechconsultants.com.

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PART 1  GENERAL

1.01  SECTION INCLUDES

A. Pipe, fittings, sleeves, escutcheons, seals, and connections for sprinkler systems.

1.02  REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings; 2012.
B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.
E. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2016.
I. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
K. ASME B36.10M - Welded and Seamless Wrought Steel Pipe; 2015.


T. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.


W. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011 (Amended 2012).

X. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015 (with March 2016 Errata).

Y. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2010.


AC. AWWA C606 - Grooved and Shouldered Joints; 2015.


1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified this section.
   1. Minimum three years experience.
   2. Approved by manufacturer.

C. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

D. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.
1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.06 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 FIRE PROTECTION SYSTEMS

B. Standpipe and Hose Systems: Comply with NFPA 14.
C. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 BURIED PIPING

   3. Joints: Welded in accordance with AWS D1.1/D1.1M.
   4. Casing: Closed glass cell insulation.

B. Copper Tube: ASTM B75/B75M or ASTM B88 (ASTM B88M), O60 or O50 temper.
   1. Type: Type K (A).
   2. Fittings: ASME B16.18, cast copper alloy, solder joint, pressure type.
   3. Joints: AWS A5.8M/A5.8 Classification BCuP-3 or BCuP-4 copper/silver braze.
   4. Casing: Closed glass cell insulation.

   2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket.
2.03 ABOVE GROUND PIPING

A. Steel Pipe: Schedule 40, black.
   1. Steel Fittings: Class 150.
   4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
   5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

   2. Joints: AWWA C111/A21.11, SBR or Vulcanized styrene butadiene rubber gasket.
   3. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.04 PIPE SLEEVES

A. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.
   4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

B. Clearances:
   1. Provide allowance for insulated piping.
   2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
   3. Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

2.05 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Modular/Mechanical Seal:
   1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
   2. Provide watertight seal between pipe and wall/casing opening.
   3. Elastomer element size and material in accordance with manufacturer’s recommendations.
   4. Glass reinforced plastic pressure end plates.
2.06 ESCUTCHEONS
A. Material:
1. Fabricate from nonferrous metal.
B. Construction:
1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.07 PIPE HANGERS AND SUPPORTS
A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
D. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
E. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
F. Vertical Support: Steel riser clamp.
G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.08 EXPANSION JOINTS AND LOOPS- HOSE AND BRAID
A. Provide flexible loops with two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return with support bracket and air release or drain plug.
B. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.
C. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
   1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
   2. Accommodate the Following:
      b. Lateral Movement: _____ inch.
      c. Angular Rotation: 15 degrees.
      d. Force developed by 1.5 times specified maximum allowable operating pressure.
   3. Provide necessary accessories including, but not limited to, swivel joints.
2.09 MECHANICAL COUPLINGS

A. Manufacturers:
1. Tyco Fire Protection Products; Grinnell G-Fire Figure 705 Grooved Flexible Couplings: www.tyco-fire.com/#sle.
2. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.

B. Rigid Mechanical Couplings for Grooved Joints:
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel or __________.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
6. Bolts and Nuts: Hot dipped galvanized or zinc electroplated steel.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and foreign material, from inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
B. Install standpipe piping, hangers, and supports in accordance with NFPA 14.
C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
D. Install piping to conserve building space, to not interfere with use of space and other work.
E. Group piping whenever practical at common elevations.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
G. Inserts:
1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

H. Pipe Hangers and Supports:
   1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   2. Place hangers within 12 inches of each horizontal elbow.
   3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   6. Provide copper plated hangers and supports for copper piping.

I. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

J. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

K. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
   1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
   2. Aboveground Piping:
      b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
   3. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.
   4. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

L. Manufactured Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a water-tight seal.
   6. Install in accordance with manufacturer’s recommendations.

M. Escutcheons:
   1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.

3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

N. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION
SECTION 21 05 23 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Two-piece ball valves with indicators.
B. Check valves.
C. Bronze OS&Y gate valves.
D. NRS gate valves.
E. Indicator posts.
F. Trim and drain valves.

1.02 ABBREVIATIONS AND ACRONYMS

A. NRS: Non-rising stem.
B. OS&Y: Outside screw and yoke.
C. PTFE: Polytetrafluoroethylene.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.
C. ASME B31.9 - Building Services Piping; 2014.
D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.
E. AWWA C606 - Grooved and Shouldered Joints; 2015.
I. UL 262 - Gate Valves for Fire-Protection Service; Current Edition, Including All Revisions.
J. UL 312 - Check Valves for Fire-Protection Service; Current Edition, Including All Revisions.

K. UL 789 - Indicator Posts for Fire-Protection Service; Current Edition, Including All Revisions.


1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications:
   1. Obtain valves for each valve type from single manufacturer.

B. Where listed products are specified, provide products listed, classified, and labeled by FM (AG), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.

C. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors and maintain at higher than ambient dew point temperature.
      b. If outdoor storage is unavoidable, store valves off the ground in watertight enclosures.

C. Use the following precautions for handling:
   1. Use sling to handle large valves, rigged to avoid damage to exposed parts.
   2. Do not use operating handles or stems as lifting or rigging points.
PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. UL Listed: Provide valves listed in UL (DIR) under following headings and bearing UL mark:
   1. Main Level: HAMV - Fire Main Equipment.
      a. Level 1: HCBZ - Indicator Posts, Gate Valve.
      b. Level 1: HLOT - Valves.
      a. Level 1: VQGU - Valves, Trim, and Drain.

B. FM Global Approved: Provide valves listed in FM (AG) Approval Guide under the following headings:
   1. Automated Sprinkler Systems:
      a. Indicator posts.
      b. Valves:
         1. Gate valves.
         2. Single check valves.
         3. Miscellaneous valves.

C. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B1.20.1 for threads on threaded-end valves.
   3. ASME B31.9 for building services piping valves.

D. Comply with AWWA C606 for grooved-end connections.

E. Comply with NFPA 13 for valves.

F. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Actuator Types:
   1. Worm-gear actuator with handwheel for quarter-turn valves, except trim and drain valves.
   2. Handwheel: For other than quarter-turn trim and drain valves.
   3. Hand-lever: For quarter-turn trim and drain valves 2 NPS and smaller.

2.02 TWO-PIECE BALL VALVES WITH INDICATORS

A. UL 1091, except with ball instead of disc and FM (AG) standard listing for indicating valves (butterfly or ball type), Class Number 1112.

B. Description:
   2. Body Design: Two piece.
   3. Body Material: Forged brass or bronze.
4. Port Size: Full or standard.
5. Seat: PTFE.
6. Stem: Bronze or stainless steel.
7. Ball: Chrome-plated brass.
8. Actuator: Worm gear or traveling nut.
9. Supervisory Switch: Internal or external.
10. End Connections for Valves 1 NPS through 2 NPS: Threaded ends.
11. End Connections for Valves 2-1/2 NPS: Grooved ends.

2.03 CHECK VALVES
A. UL 312 and FM (AG) standard listing for check valves, Class Number 1045.
B. Minimum Pressure Rating: 175 psig.
C. Type: Center guided check valve.
D. Body Material: Cast iron, ductile iron.
E. Center guided check with elastomeric seal.
F. Hinge Spring: Stainless steel.
G. End Connections: Flanged, grooved, or threaded.

2.04 BRONZE OS&Y GATE VALVES
A. UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).
B. Minimum Pressure Rating: 175 psig.
C. Body and Bonnet Material: Bronze or brass.
D. Wedge: One-piece bronze or brass.
E. Wedge Seat: Bronze.
F. Stem: Bronze or brass.
G. Packing: Non-asbestos PTFE.
H. Supervisory Switch: External.
I. End Connections: Threaded.

2.05 NRS GATE VALVES
A. UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).
B. Minimum Pressure Rating: 175 psig.
C. Body and Bonnet Material: Cast or ductile iron.
D. Wedge: Cast or ductile iron with elastomeric coating.
E. Stem: Brass or bronze.
F. Packing: Non-asbestos PTFE.
G. Supervisory Switch: External.
H. End Connections: Flanged.

2.06 INDICATOR POSTS
A. UL 789 and FM (AG) standard listing for indicator posts.
B. Type: Underground.
C. Base Barrel Material: Cast or ductile iron.
D. Cap: Cast or ductile iron.
E. Operation: Wrench.

2.07 TRIM AND DRAIN VALVES
A. Ball Valves:
   1. Description:
      b. Body Design: Two piece.
      c. Body Material: Forged brass or bronze.
      d. Port Size: Full or standard.
      e. Seat: PTFE.
      f. Stem: Bronze or stainless steel.
      g. Ball: Chrome-plated brass.
      h. Actuator: Hand-lever.
      i. End Connections for Valves 1 NPS through 2-1/2 NPS: Threaded ends.
      j. End Connections for Valves 1-1/4 NPS and 2-1/2 NPS: Grooved ends.

B. Angle Valves:
   1. Description:
      b. Body Material: Brass or bronze.
      c. Ends: Threaded.
      d. Stem: Bronze.
      e. Disc: Bronze.
      f. Packing: Asbestos free.
      g. Handwheel: Malleable iron, bronze, or aluminum.
PART 3 EXECUTION

3.01 EXAMINATION
A. Confirm valve interior to be free of foreign matter and corrosion.
B. Remove packing materials.
C. Examine guides and seats by operating valves from the fully open position to the fully closed position.
D. Examine valve threads and mating pipe for form and cleanliness.

3.02 INSTALLATION
A. Comply with specific valve installation requirements and application in the following Sections:
   1. Section 21 13 00 for application of valves in wet and dry pipe, fire-suppression sprinkler systems.
B. Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
   1. Install permanent identification signs indicating portion of system controlled by each valve.
C. Install check valve in water supply connections and backflow preventer at potable water supply connections.
D. Valves with threaded connections to have unions at equipment arranged for easy access, service, maintenance, and equipment removal without system shutdown.
E. Valves in horizontal piping installed with stem at or above the pipe center.
F. Position valves to allow full stem movement.
G. Install valve tags. Comply with Section 21 05 53 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

END OF SECTION
SECTION 21 05 53 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Pipe markers.
D. Ceiling tacks.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS
A. Automatic Controls: Tags.
B. Control Panels: Nameplates.
C. Instrumentation: Tags.
D. Major Control Components: Nameplates.
E. Piping: Pipe markers.
F. Pumps: Nameplates.
G. Relays: Tags.
H. Small-sized Equipment: Tags.
I. Thermostats: Nameplates.
J. Valves: Tags and ceiling tacks where above lay-in ceilings.
2.02 NAMEPLATES
A. Manufacturers:
B. Description: Laminated three-layer plastic with engraved letters.
   2. Letter Height: 1/4 inch.

2.03 TAGS
A. Manufacturers:
B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS
A. Manufacturers:
B. Color: Comply with ASME A13.1.
C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
D. Color code as follows:
   1. Fire Quenching Fluids: Red with white letters.

2.05 CEILING TACKS
A. Description: Steel with 3/4 inch diameter color coded head.
PART 3 EXECUTION

3.01 PREPARATION
   A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION
   A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
   B. Install tags with corrosion resistant chain.
   C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
   D. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
SECTION 21 13 00 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Wet-pipe sprinkler system.
   B. Pre-action sprinkler system.
   C. System design, installation, and certification.
   D. Fire department connections.

1.02 REFERENCE STANDARDS
   C. UL 405 - Fire Department Connection Devices; Current Edition; Including All Revisions.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
      1. See Section 01 60 00 - Product Requirements, for additional provisions.
      2. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
      3. Sprinkler Wrenches: For each sprinkler type.

1.04 QUALITY ASSURANCE
   A. Maintain one copy of referenced design and installation standard on site.
   B. Comply with FM (AG) requirements.
   C. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.05 EXTRA MATERIALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of
sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sprinklers, Valves, and Equipment:

2.02 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for entire building.
B. Occupancy: Light hazard; comply with NFPA 13.
C. Water Supply: Determine volume and pressure from water flow test data.
D. Provide fire department connections where indicated.
E. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.03 SPRINKLERS

A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Escutcheon Plate Finish: Enamel, color as selected.
   4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
B. Exposed Area Type: Pendant type with guard.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Escutcheon Plate Finish: Enamel, color as selected.
   4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
D. Guards: Finish to match sprinkler finish.
E. Spray Nozzles: Brass with solid cone discharge, 30 degrees of arc with blow-off dust cap.
F. Flexible Drop System: Stainless steel, multiple use, open gate type.
1. Application: Use to properly locate sprinkler heads.
2. Include all supports and bracing.
3. Provide braided type tube as required for the application.
4. Manufacturers:

2.04 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.
   3. Replaceable internal components without removing valve from installed position.

B. Preaction Valve:
   1. Operated by detection system listed for releasing service and independent of building fire alarm system with provisions for local, manual, and indicated remote releases.
   2. Incorporate mechanical latching mechanism incorporating valve clappers independent of system water pressure fluctuations.
   3. Provide test detection device for each actuation circuit adjacent to each controlled valve in accordance with NFPA 13.

C. Backflow Preventer: Double check valve assembly backflow preventer with drain and OS & Y gate valve on each end.

D. Test Connections:
   1. Inspector's Test Connection for Preaction Systems:
      a. Provide test connections approximately 6 ft above floor for each or portion of each sprinkler system equipped with an alarm device, located at the most remote part of each system.
      b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
      c. Supply discharge orifice with same size as corresponding sprinkler orifice.
      d. Limit vertical height of exterior wall penetration to 2 ft above finished grade.
   2. Backflow Preventer Test Connection:
      a. Provide downstream of the backflow prevention assembly, listed hose valves with 2.5 inch National Standard male hose threads with cap and chain.
      b. Furnish one valve for each 250 gpm of system demand or fraction thereof.
      c. Provide permanent sign reading "Test Valve" in accordance with Section 22 05 53.

E. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy chrome plated gong and motor housing, nylon bearings, and inlet strainer.

F. Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.

G. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.
H. Fire Department Connections:
   1. Type: Flush, wall mount made of corrosion resistant metal complying with UL 405.
      a. Inlets: Two way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.
      b. Configuration: Horizontal.
      d. Finish: Brass or bronze.
      e. Signage: Raised or engraved lettering 1 inch minimum indicating system type.

2.05 PREACTION VALVE CONTROL PANEL
   A. Provide a modular type control panel for electrically operated detection and extinguishing systems for each preaction valve.

2.06 PRESSURE MAINTENANCE PUMP
   A. Type: Close coupled motor and positive displacement pump unit.
   B. Construction: Bronze with stainless steel shafts, carbon bearings.
   C. Motor: Open drip proof, permanently lubricated.
   D. Accessories: Include flexible hose connections.

2.07 AIR COMPRESSOR
   A. Compressor: Single unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with referenced NFPA design and installation standard.
   B. Install equipment in accordance with manufacturer’s instructions.
   C. Locate outside alarm gong on building wall as indicated.
   D. Place pipe runs to minimize obstruction to other work.
   E. Place piping in concealed spaces above finished ceilings.
   F. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
G. Install air compressor on vibration isolators. Refer to Section 22 05 48.
H. Flush entire piping system of foreign matter.
I. Install guards on sprinklers where indicated.
J. Hydrostatically test entire system.
K. Require test be witnessed by Fire Marshal.

END OF SECTION
SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Pipe sleeves.
   B. Manufactured sleeve-seal systems.

1.02 REFERENCE STANDARDS
   A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2016.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 PIPE SLEEVES
   A. Vertical Piping:
      1. Sleeve Length: 1 inch above finished floor.
      2. Provide sealant for watertight joint.
      4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
   B. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
   C. Pipe Passing Through Below Grade Exterior Walls:
      1. Zinc coated or cast iron pipe.
      2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
   D. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:
      1. Galvanized steel pipe or black iron pipe with asphalt coating.
      2. Connect sleeve with floor plate except in mechanical rooms.
   E. Pipe Passing Through Mechanical Room Floors above Basement:
1. Galvanized steel pipe or black iron pipe with asphalt coating.
2. Connect sleeve with floor plate except in mechanical rooms.

F. Penetrations in concrete beam flanges are permitted but are prohibited through ribs or beams without prior approval from the Architect.

G. Clearances:
   1. Provide allowance for insulated piping.
   2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
   3. All Rated Openings: Caulked tight with fire stopping material conforming to ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Modular/Mechanical Seal:
   1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
   2. Provide watertight seal between pipe and wall/casing opening.
   3. Elastomer element size and material in accordance with manufacturer’s recommendations.
   4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
B. Install piping to conserve building space, to not interfere with use of space and other work.
C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
D. Inserts:
   1. Provide inserts for placement in concrete formwork.
E. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
1. **Underground Piping:** Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.

2. **Aboveground Piping:**
   a. Pack solid using mineral fiber conforming to ASTM C592.
   b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.

3. **All Rated Openings:** Caulk tight with fire stopping material conforming to ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

4. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

F. **Manufactured Sleeve-Seal Systems:**
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a water-tight seal.
   6. Install in accordance with manufacturer’s recommendations.

G. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 **CLEANING**

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

**END OF SECTION**
SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1  GENERAL

1.01  SECTION INCLUDES

A.  Flow meters.
B.  Pressure gauges and pressure gauge taps.
C.  Thermometers and thermometer wells.

1.02  REFERENCE STANDARDS

A.  ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
E.  AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2015.
F.  AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2015.
G.  AWWA C702 - Cold-Water Meters -- Compound Type; 2015.
I.  UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
J.  UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.03  SUBMITTALS

A.  See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2  PRODUCTS

2.01  PRESSURE GAUGES

A.  Manufacturers:
1.  Dwyer Instruments, Inc; ______: www.dwyer-inst.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
1. Case: Steel with brass bourdon tube.
2. Size: 4-1/2 inch diameter.
3. Mid-Scale Accuracy: One percent.

2.02 PRESSURE GAUGE TAPPPINGS
A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
B. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.03 STEM TYPE THERMOMETERS
A. Manufacturers:
   1. Dwyer Instruments, Inc; ______: www.dwyer-inst.com/#sle.
   2. Omega Engineering, Inc; ______: www.omega.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   4. Accuracy: 2 percent, per ASTM E77.
   5. Calibration: Degrees F.

C. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   4. Accuracy: 2 percent, per ASTM E77.
   5. Calibration: Degrees F.

2.04 TEST PLUGS
A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

C. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

E. Coil and conceal excess capillary on remote element instruments.

F. Provide instruments with scale ranges selected according to service with largest appropriate scale.

G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

H. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

I. Locate test plugs adjacent thermometers and thermometer sockets.

3.02 SCHEDULES

A. Positive Displacement Meters, Location:
   1. Domestic cold water.

B. Pressure Gauges, Location and Scale Range:
   1. Pumps, 0 to 150 psi.
   2. Pressure tanks, 0 to 150 psi.
   3. Sprinkler system, 0 to 150 psi.
   4. Pressure reducing valves, 0 to 150 psi.
   5. Backflow preventers, 0 to 150 psi.

C. Stem Type Thermometers, Location and Scale Range:
   1. Domestic hot water supply and recirculation, 0 to 200 degrees F.

END OF SECTION
SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Applications.
   B. General requirements.
   C. Angle valves.
   D. Ball valves.
   E. Check valves.
   F. Gate valves.
   G. Plug valves.

1.02 ABBREVIATIONS AND ACRONYMS
   A. NRS: Non-rising stem.
   B. OS&Y: Outside screw and yoke.

1.03 REFERENCE STANDARDS
   A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.
   E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
   G. ASME B31.9 - Building Services Piping; 2014.
   H. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.
M. AWWA C606 - Grooved and Shouldered Joints; 2015.
N. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; 2011.
P. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
Q. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; 2011.
R. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.
S. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE
A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.
B. Welding Materials and Procedures: Conform to ASME BPVC-IX.

PART 2 PRODUCTS

2.01 APPLICATIONS
A. See drawings for specific valve locations.
B. Provide the following valves for the applications if not indicated on drawings:
   1. Shutoff: Ball, or gate.
2. Swing Check (Pump Outlet):
   a. 2 NPS and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
   b. 2-1/2 NPS and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.

C. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

D. Required Valve End Connections for Non-Wafer Types:
   1. Steel Pipe:
      a. 2 NPS and Smaller: Threaded ends.
      b. 2-1/2 NPS to 4 NPS: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
      c. 5 NPS and Larger: Grooved or flanged ends.
   2. Copper Tube:
      a. 2 NPS and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
      b. 2-1/2 NPS to 4 NPS: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
      c. 5 NPS and Larger: Grooved or flanged ends.

E. Low Pressure, Compressed Air Valves 150 psig or Less:
   1. 2 NPS and Smaller:
      a. Ball: One piece, full port, brass with brass trim.
      b. Bronze Swing Check: Class 125, bronze disc.
   2. 2-1/2 NPS and Larger:
      a. Iron, 2-1/2 NPS to 4 NPS: Provide with threaded ends.
      b. Iron Swing Check: Class 125, metal seats.
      c. Iron Grooved-End Swing Check: 300 CWP.
      d. Iron Gate: Class 125, NRS.

F. High Pressure, Compressed Air Valves 150 psig to 200 psig:
   1. 2 NPS and Smaller:
      a. Ball: One piece, full port, brass with brass trim.
      b. Bronze Swing Check: Class 125, bronze disc.
   2. 2-1/2 NPS and Larger:
      a. Iron Valves, 2-1/2 NPS to 4 NPS: Provide with threaded ends.
      b. Iron Swing Check: Class 125, metal seats.
      c. Iron Gate: Class 125, NRS.

G. Domestic, Hot and Cold Water Valves:
   1. 2 NPS and Smaller:
      a. Bronze and Brass: Provide with solder-joint or threaded ends.
      b. Bronze Angle: Class 125, bronze disc.
      c. Ball: One piece, full port, brass or bronze with brass trim.
      d. Bronze Swing Check: Class 125, bronze disc.
   2. 2-1/2 NPS and Larger:
      a. Iron, 2-1/2 NPS to 4 NPS: Provide with threaded or flanged ends.
      b. Iron Ball: Class 150.
c. Iron Swing Check: Class 125, metal seats.
d. Iron Grooved-End Swing Check: 300 CWP.
e. Iron Gate: Class 125, NRS.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Handwheel: Valves other than quarter-turn types.

D. Valves in Insulated Piping: With 2 NPS stem extensions and the following features:
   1. Gate Valves: Rising stem.
   2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

E. Valve-End Connections:
   5. Grooved End Connections: AWWA C606.

F. General ASME Compliance:


H. Bronze Valves:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

2.03 BRONZE ANGLE VALVES

A. Class 125: CWP Rating: 200 psig; and ____________________________.
   1. Comply with MSS SP-80, Type 1.
   3. Ends: Threaded.
   4. Stem: Bronze.
   5. Disc: Bronze.
   7. Handwheel: Bronze or aluminum.
2.04 BRONZE BALL VALVES

A. Two Piece, Regular Port and ____________ with Bronze Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 150 psig.
   3. CWP Rating: 600 psig.
   5. Ends: Threaded.
   6. Seats: PTFE.
   7. Stem: Bronze.
   8. Ball: Chrome plated brass.

2.05 IRON BALL VALVES

A. Class 125, Full Port, Stainless Steel Trim:
   1. Comply with MSS SP-72.
   2. CWP Rating: 200 psig.
   5. Seats: PTFE.
   8. Operator: Lever, with locking handle.

2.06 BRONZE SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig (1380 kPa) and ________________.
   1. Comply with MSS SP-80, Type 3.
   2. Design: Horizontal flow.
   4. Ends: Threaded as indicated.
   5. Disc: Bronze.

2.07 IRON SWING CHECK VALVES

A. Class 125:
   1. Comply with MSS SP-71, Type I.
   2. CWP Rating: 200 psig.
   3. Design: Clear or full waterway.
   5. Ends: Flanged as indicated.
   6. Trim: Composition.
   7. Seat Ring and Disc Holder: Bronze.
   8. Disc: PTFE or ____. 
2.08 **IRON SWING CHECK VALVES WITH CLOSURE CONTROL**

A. Class 125 with Lever and Spring-Closure Control.
   1. Comply with MSS SP-71, Type I.
   2. Description:
      a. CWP Rating: 200 psig.
      b. Design: Clear or full waterway.
      c. Body: ASTM A126, gray iron with bolted bonnet.
      d. Ends: Flanged as indicated.
      e. Trim: Bronze.
      f. Gasket: Asbestos free.
      g. Closer Control: Factory installed, exterior lever, and weight.

2.09 **IRON GROOVED-END SWING CHECK VALVES**

A. 300 CWP:
   1. CWP Rating: 300 psig.
   2. Body: ASTM A536, Grade 65-45-12 ductile iron.
   3. Seal: EPDM or ____.
   4. Disc: Ductile iron.
   5. Coating: Black, non-lead paint.

2.10 **BRONZE GATE VALVES**

A. Non-Rising Stem (NRS):
   1. Comply with MSS SP-80, Type I.
   2. Class 125: CWP Rating: 200 psig, and ____________________________.
   4. Ends: Threaded or solder joint joint.
   5. Stem: Bronze.
   7. Packing: Asbestos free.
   8. Handwheel: Malleable iron, bronze, or aluminum.

2.11 **IRON GATE VALVES**

A. NRS or OS & Y:
   1. Comply with MSS SP-70, Type I.
   5. Trim: Bronze.
   7. Packing and Gasket: Asbestos free.

2.12 **LUBRICATED PLUG VALVES**

A. Regular Gland with Flanged Ends:
1. Comply with MSS SP-78, Type II.
3. Body: ASTM A48/A48M or ASTM A126, cast iron with lubrication sealing system.
4. Pattern: Regular or short.
5. Plug: Cast iron or bronze with sealant groove.

PART 3 EXECUTION

3.01 EXAMINATION
A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.
B. Verify valve parts to be fully operational in all positions from closed to fully open.
C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION
A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

END OF SECTION
SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Support and attachment components for equipment, piping, and other plumbing work.

1.02 REFERENCE STANDARDS
   D. MFMA-4 - Metal Framing Standards Publication; 2004.

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
      2. Coordinate the work with other trades to provide additional framing and materials required for installation.
      3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
      4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
      5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
   B. Sequencing:
      1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE
   A. Comply with applicable building code.
B. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of ___. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
   a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Metal Channel (Strut) Framing Systems:
1. Manufacturers:
   c. Unistrut, a brand of Atkore International Inc; __________: www.unistrut.com/#sle.
   d. Substitutions: See Section 01 60 00 - Product Requirements.
   e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
2. Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
4. Channel Material:
   a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
5. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch diameter.
      b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
      c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
      d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.

D. Anchors and Fasteners:
   1. Manufacturers - Mechanical Anchors:
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
   3. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
   4. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
   7. Steel: Use beam clamps, machine bolts, or welded threaded studs.
   10. Plastic and lead anchors are not permitted.
   11. Powder-actuated fasteners are not permitted.
   12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
      b. Channel Material: Use galvanized steel.
      c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
      d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
   13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive support and attachment components.
C. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Field-Welding (where approved by Architect): Comply with Section 05 50 00.

H. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
   5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

J. Secure fasteners according to manufacturer's recommended torque settings.

K. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION
SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Pipe markers.
   D. Ceiling tacks.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS
   A. Piping: Pipe markers.
   B. Pumps: Nameplates.
   C. Small-sized Equipment: Tags.
   D. Tanks: Nameplates.
   E. Valves: Tags and ceiling tacks where located above lay-in ceiling.
   F. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Description: Laminated three-layer plastic with engraved letters.
      2. Letter Height: 1/4 inch.

2.03 TAGS
A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

2.04 PIPE MARKERS
A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Comply with ASME A13.1.
C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
D. Color code as follows:
   1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.
   2. Fire Quenching Fluids: Red with white letters.
   3. Toxic and Corrosive Fluids: Orange with black letters.
   4. Flammable Fluids: Yellow with black letters.
   6. Compressed Air: Blue with white letters.

2.05 CEILING TACKS
A. Description: Steel with 3/4 inch diameter color coded head.
B. Color code as follows:
   1. Plumbing Valves: Green.

PART 3 EXECUTION

3.01 PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.
3.02 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer’s instructions.

D. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.
B. Jackets and accessories.

1.02 REFERENCE STANDARDS


1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer’s identification, product density, and thickness.

1.05 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.
B. Maintain temperature before, during, and after installation for minimum of 24 hours.
PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER

A. Manufacturers:
   2. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation: www.knaufinsulation.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
   1. ‘K’ Value: ASTM C177, 0.23 at 75 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 EXPANDED POLYSTYRENE

A. Insulation: ASTM C578; rigid closed cell.
   1. ‘K’ Value: 0.23 at 75 degrees F.
   2. Maximum Service Temperature: 165 degrees F.
   3. Maximum Water Vapor Permeance: 5.0 perms.

2.04 JACKETS

A. PVC Plastic.
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 10 mil.
      e. Connections: Brush on welding adhesive.
2. Covering Adhesive Mastic: Compatible with insulation.

PART 3  EXECUTION

3.01  EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02  INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
G. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
H. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert Location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

END OF SECTION
SECTION 22 10 05 - PLUMBING PIPING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
   1. Sanitary sewer.
   2. Domestic water.
   3. Storm water.
   4. Flanges, unions, and couplings.
   5. Pipe hangers and supports.

1.02  REFERENCE STANDARDS

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
E. ASME B31.9 - Building Services Piping; 2014.
M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.


X. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2010.


AA. AWWA C651 - Disinfecting Water Mains; 2014.


AE. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2015.


AJ. PPI TR-4 - PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe; 2017.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.04 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

C. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.

2.03 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight (for use in plenums only).
   1. Fittings: Cast iron.

B. PVC Pipe: ASTM D2665.
   1. Fittings: PVC.

2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Pipe: ASTM B42, hard drawn.
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

1. Fittings: Ductile or gray iron, standard thickness.
2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.

2.05 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
3. Mechanical Press Sealed Fittings: Double pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.
   a. Manufacturers:
      2. Viega LLC; ______: www.viega.com/#sle.

B. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
1. Manufacturers:
   a. Uponor, Inc; ______: www.uponorengineering.com/#sle.
   b. Viega LLC; ______: www.viega.com/#sle.
   c. Zurn Industries, LLC; ______: www.zurn.com/#sle.
2. PPI TR-4 Pressure Design Basis:
   a. 100 psig at maximum 180 degrees F.

C. Stainless Steel Pipe: ASTM A269/A269M, Grade TP304 alloy.
1. Mechanical Press Sealed Fittings: Double pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.
   a. Manufacturers:
      2. Viega LLC; ______: www.viega.com/#sle.

2.06 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034. (Solid-Core Schedule 40).
1. Fittings: PVC.

2.07 STORM WATER PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D2665 or ASTM D3034. (Solid-Core Schedule 40).
1. Fittings: PVC.

2.08 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.09 NATURAL GAS PIPING, ABOVE GRADE
A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   2. Joints: Threaded or welded to ASME B31.1.

2.10 FLANGES, UNIONS, AND COUPLINGS
A. Unions for Pipe Sizes 3 Inches and Under:
   1. Ferrous pipe: Class 150 malleable iron threaded unions.
   2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
   2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.11 PIPE HANGERS AND SUPPORTS
A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
   5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.

B. Plumbing Piping - Drain, Waste, and Vent:
   1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   3. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:
1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
7. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
5. Other Types: As required.

2.12 STRAINERS
A. Size 2 inch and Under:
1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 1-1/2 inch to 4 inch:
1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION
A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION
A. Install in accordance with manufacturer’s instructions.
B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
E. Group piping whenever practical at common elevations.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
   1. Refer to Section 22 07 19.
H. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 08 31 00.
I. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.
J. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
K. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
L. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

3.04 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
A. Prior to starting work, verify system is complete, flushed and clean.
B. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
C. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

D. Maintain disinfectant in system for 24 hours.

E. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

F. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

G. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.05 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe Size: 1/2 inches to 1-1/4 inches:
         1. Maximum Hanger Spacing: 6.5 ft.
      b. Pipe Size: 1-1/2 inches to 2 inches:
         1. Maximum Hanger Spacing: 10 ft.
      c. Pipe Size: 2-1/2 inches to 3 inches:
         1. Maximum Hanger Spacing: 10 ft.
         2. Hanger Rod Diameter: 1/2 inch.
      d. Pipe Size: 4 inches to 6 inches:
         1. Maximum Hanger Spacing: 10 ft.
   2. Plastic Piping:
      a. All Sizes:
         1. Maximum Hanger Spacing: 6 ft.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drains.
B. Cleanouts.
C. Hose bibbs.
D. Hydrants.
E. Washing machine boxes and valves.
F. Refrigerator valve and recessed box.
G. Back water valves.
H. Backflow preventers.
I. Double check valve assemblies.
J. Water hammer arrestors.
K. Mixing valves.

1.02 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor and Trench Drains; 2016.
B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2008 (Reaffirmed 2012).
C. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2004, with Errata.
D. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent; 2009.
E. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers; 2011.
F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011 (Reaffirmed 2016).
1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS
   A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS
   A. Manufacturers:

   B. Roof Drains:
      1. Assembly: ASME A112.6.4.
      2. Body: Lacquered cast iron with sump.
      4. Accessories: Coordinate with roofing type, refer to Section ________:
         a. Membrane flange and membrane clamp with integral gravel stop.
         b. Adjustable under deck clamp.
         c. Waterproofing flange.

   C. Roof Overflow Drains:
      1. Lacquered cast iron body and clamp collar and bottom clamp ring; pipe extended to 4 inches above flood elevation.

   D. Downspout Nozzles:
      1. Bronze round with straight bottom section.

   E. Area Drains:
      1. Assembly: ASME A112.6.4.
      2. Body: Lacquered cast iron with sump.
      4. Accessories: Membrane flange and membrane clamp with integral gravel stop, with waterproofing flange.

   F. Linear Drains:

   G. Floor Drains:
1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with
double drainage flange, weep holes, reversible clamping collar, and round,
adjustable nickel-bronze strainer.

H. Floor Sinks:
1. Lacquered cast iron body with dome strainer and seepage flange.

2.03 CLEANOUTS

A. Manufacturers:

B. Cleanouts at Exterior Surfaced and Unsurfaced Areas:
1. Line type with lacquered cast iron body and round epoxy coated gasketed cover.

C. Cleanouts at Interior Finished Floor Areas:
1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded
top assembly, and round gasketed scored cover in service areas and round
gasketed depressed cover to accept floor finish in finished floor areas.

D. Cleanouts at Interior Finished Wall Areas:
1. Line type with lacquered cast iron body and round epoxy coated gasketed cover,
and round stainless steel access cover secured with machine screw.

2.04 HOSE BIBBS

A. Manufacturers:
3. Woodford Manufacturing Company.

B. Interior Hose Bibbs:
1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose
thread spout, chrome plated where exposed with handwheel, integral vacuum
breaker in conformance with ASSE 1011.

2.05 HYDRANTS

A. Manufacturers:
2. Zurn Industries, LLC; ______: www.zurn.com/#sle.
3. Woodford Manufacturing Company.

B. Wall Hydrants:
1. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate
hose thread spout, handwheel, and integral vacuum breaker.
2.06 WASHING MACHINE BOXES AND VALVES

A. Box Manufacturers:
   1. IPS Corporation/Water-Tite; ______: www.ipscorp.com/#sle.
   2. Oatey Supply Chain Services, Inc; ______: www.oatey.com/#sle.

B. Valve Manufacturers:
   1. IPS Corporation/Water-Tite; ______: www.ipscorp.com/#sle.
   2. Zurn Industries, LLC; ______: www.zurn.com/#sle.

C. Description: Plastic preformed rough-in box with brass valves with single lever handle, socket for 2 inch waste, slip in finishing cover.

2.07 REFRIGERATOR VALVE AND RECESSED BOX

A. Box Manufacturers:
   1. IPS Corporation/Water-Tite; ______: www.ipscorp.com/#sle.
   2. Oatey Supply Chain Services, Inc; ______: www.oatey.com/#sle.

B. Valve Manufacturers:
   1. IPS Corporation/Water-Tite; ______: www.ipscorp.com/#sle.
   2. Zurn Industries, LLC; ______: www.zurn.com/#sle.

C. Description: Plastic preformed rough-in box with brass valves with 1/4 turn handle, slip in finishing cover.

2.08 BACK WATER VALVES

A. Manufacturers:

B. Cast Iron Back Water Valves: ASME A112.6.4; lacquered cast iron body and cover, brass valve, extension sleeve, and access cover.

C. Plastic Back Water Valves: ABS body and valve, extension sleeve, and access cover.

2.09 BACKFLOW PREVENTERS

A. Manufacturers:
   2. Watts Regulator Company, a part of Watts Water Technologies; ______: www.watssregulator.com/#sle.

B. Reduced Pressure Backflow Preventers:
1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.10 DOUBLE CHECK VALVE ASSEMBLIES

A. Manufacturers:
   2. Watts Regulator Company, a part of Watts Water Technologies; ______: www.wattsregulator.com/#sle.

B. Double Check Valve Assemblies:
   1. ASSE 1012; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

2.11 WATER HAMMER ARRESTORS

A. Manufacturers:
   2. Watts Regulator Company, a part of Watts Water Technologies; ______: www.wattsregulator.com/#sle.

B. Water Hammer Arrestors:
   1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.12 MIXING VALVES

A. Thermostatic Mixing Valves:
   1. Manufacturers:
      c. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.

B. Pressure Balanced Mixing Valves:
   1. Manufacturers:
   2. Valve: Chrome plated cast brass body, stainless steel cylinder, integral temperature adjustment.
   3. Accessories:
      a. Volume control shut-off valve on outlet.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

F. Pipe relief from backflow preventer to nearest drain.

G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to washing machine outlets or other quick closing valves.

END OF SECTION
SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Water Heaters:
   B. In-line circulator pumps.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.

1.04 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 WATER HEATERS
   A. Commercial Gas Fired:
      1. Type: Automatic, natural gas-fired, vertical storage.
      2. Performance per schedule.
      3. Tank: Glass lined welded steel ASME labeled; multiple flue passages, 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
      4. Accessories:
         b. Dip Tube: Brass.
         c. Drain valve.
         d. Anode: Magnesium.
         e. Temperature and Pressure Relief Valve: ASME labeled.
      5. Certified For The Following Applications:
         a. Automatic storage water heater.
         b. For operation at 140 degrees F.
         c. For operation in high altitude installations.
      6. Controls: Automatic water thermostat with temperature range adjustable from 120 to 180 degrees F, automatic reset high temperature limiting thermostat factory set at 195 degrees F, gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood.
2.02 IN-LINE CIRCULATOR PUMPS

A. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.
B. Impeller: Bronze.
C. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
D. Seal: Carbon rotating against a stationary ceramic seat.
E. Drive: Flexible coupling.
F. Performance per schedule.

2.03 ELECTRICAL WORK

A. Provide electrical motor driven equipment specified complete with motors, motor starters, controls, and wiring.
B. Electrical characteristics to be as specified or indicated.
C. Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.
D. Supply manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices not shown.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer’s instructions, as required by code, and complying with conditions of certification, if any.
B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.
C. Pumps:
   1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
SECTION 22 31 00 - COMMERCIAL WATER SOFTENERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Commercial water softeners.
   2. Chemicals.
   3. Water-testing sets.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water softeners.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.
B. Field quality-control reports.
C. Warranty: Sample of special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.
1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Salt for Brine Tanks: Furnish in same form as and at least four times original load, but not less than 1000 lb. Deliver on pallets according to the following:
   a. Plain Pellet Salt: In 80-lb packages.

2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

1.07 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application.

B. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

C. ASME Compliance for FRP Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, where indicated.

D. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."

1.08 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.09 WARRANTY

1. Commercial Water Softeners, Warranty Period: From date of Substantial Completion.
   b. Brine Tanks: Five years.
   c. Control Valve: One year(s).

PART 2 - PRODUCTS

2.01 COMMERCIAL WATER SOFTENERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aquion Water Treatment Products.
2. Culligan International Company.
3. CUNO Incorporated.
6. Ecodyne Water Treatment, Inc.
7. Hungerford & Terry, Inc.
8. Integration Separation Solutions, LLC.
10. Marlo Incorporated.
11. Parker Boiler.
13. Water King.
14. WaterSoft; a division of Amtrol, Inc.

B. Description: Factory-assembled, pressure-type water softener.

2. Configuration: Twin unit with two mineral tanks and one brine tank.
   a. Pressure Rating: 100 psig minimum.
   b. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
4. Controls: Automatic; factory wired and factory mounted on unit.
   a. Adjustable duration of various regeneration steps.
   b. Push-button start and complete manual operation.
   c. Electric time clock and switch for automatic operation except for manual return to service.
5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
   a. Slow opening and closing, nonslam operation.
   b. Diaphragm guiding on full perimeter from fully open to fully closed.
   c. Isolated, dissimilar metals within valve.
   d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
6. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressure; does not require field adjustments.
   a. Demand-Initiated Control: Each mineral tank of twin mineral-tank unit is equipped with automatic-reset-head water meter that electrically activates cycle controllers to initiate regeneration at preset total in gallons. Head automatically resets to preset total in gallons for next service run. Electrical lockout prevents simultaneous regeneration of both tanks.
   b. Demand-Initiated Control: Each multiple mineral-tank unit is equipped with automatic-reset-head water meter, in common outlet header, that
electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tanks. Automatically repeats with other tanks. Electrical lockout prevents simultaneous regeneration of more than one tank.

7. Brine Tank: Combination measuring and wet-salt storing system.
   a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
   b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawal and freshwater refill.
   c. Size: Large enough for at least four regenerations at full salting.

8. Factory-Installed Accessories:
   a. Piping, valves, tubing, and drains.
   b. Sampling cocks.
   c. Main-operating-valve position indicators.
   d. Water meters.

2.02 CHEMICALS
   A. Mineral: High-capacity, sulfonated-polystyrene, ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.

2.03 WATER-TESTING SETS
   A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.04 SOURCE QUALITY CONTROL
   A. Hydrostatically test mineral tanks before shipment to a minimum of one and one-half times the pressure rating.
   B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WATER SOFTENER INSTALLATION
   A. Equipment Mounting: Install commercial water softeners on concrete base.
      1. Maintain manufacturer's recommended clearances.
      2. Arrange units so controls and devices that require servicing are accessible.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor water softener and brine tanks to substrate.

3.02 CONNECTIONS
A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where piping is installed adjacent to equipment, allow space for service and maintenance of equipment.
C. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
   1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
   2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
D. Install valved bypass in water piping around water softeners.
   1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
   2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
   3. Water piping is specified in Division 22 Section "Domestic Water Piping."
E. Install drains as indirect wastes to spill into open drains or over floor drains.

3.03 IDENTIFICATION
A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL
A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Water softeners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:

2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
4. ASTM D 1126, "Test Method for Hardness in Water."
5. ASTM D 1129, "Terminology Relating to Water."

END OF SECTION
SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water closets.
B. Urinals.
C. Lavatories.
D. Sinks.
E. Electric water coolers.
F. Showers.
G. Eye and face wash fountains.
H. Emergency showers.

1.02 REFERENCE STANDARDS

C. ASME A112.18.1 - Plumbing Supply Fittings; 2012.
D. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2013.
E. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2017.
F. ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers; 2005.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
PART 2 PRODUCTS

2.01 GENERAL

A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Water Efficiency: EPA WaterSense label is required for all water closets, urinals, lavatory faucets, and showerheads.

2.02 FLUSH VALVE WATER CLOSETS

   1. Flush Valve: Exposed (top spud).
   3. Handle Height: 44 inches or less.
   4. Supply Size: 1 inches.
   5. Outlet Size: 4 inches.
   7. Manufacturers:
      b. Zurn Industries, Inc; ______: www.zurn.com/#sle.

B. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
   1. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
   2. Manufacturers:
      b. Zurn Industries, Inc; ______: www.zurn.com/#sle.

C. Seats:
   1. Manufacturers:
      b. Church Seat Company; ______: www.churchseats.com/#sle.
      c. Zurn Industries, Inc; ______: www.zurn.com/#sle.
   2. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.

D. Water Closet Carriers:
   1. Manufacturers:
      a. JOSAM Company; ______: www.josam.com/#sle.
      b. Zurn Industries, Inc; ______: www.zurn.com/#sle.

2.03 WALL HUNG URINALS

A. Wall Hung Urinal Manufacturers:

   1. Flush Volume: 0.125 gallons, maximum.
   2. Flush Style: Washout.
   3. Flush Valve: Exposed (top spud).
   5. Trap: Integral.
   6. Removable stainless steel strainer.
   8. Outlet Size: 2 inches.

C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
   1. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
   2. Manufacturers:
      b. Zurn Industries, Inc; ______: www.zurn.com/#sle.

D. Carriers:
   1. Manufacturers:
      a. JOSAM Company; ______: www.josam.com/#sle.
      b. Zurn Industries, Inc; ______: www.zurn.com/#sle.

2.04 LAVATORIES

A. Lavatory Manufacturers:

B. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, _____ by _____ inch minimum, with 4 inch high back, rectangular basin with splash lip, front overflow, and soap depression.

C. Vitreous China Counter Top Basin: ASME A112.19.2; vitreous china self-rimming counter top lavatory, ______ with drillings on 4 inch centers, front overflow, soap depression, seal of putty, calking, or concealed vinyl gasket.

D. Supply Faucet Manufacturers:

E. Supply Faucet: ASME A112.18.1; chrome plated supply fitting with open grid strainer, water economy aerator with maximum flow of 0.5 gallon per minute (low-flow), indexed handles.

F. Accessories:
1. Chrome plated 17 gage, 0.0538 inch brass P-trap with clean-out plug and arm with escutcheon.
2. Offset waste with perforated open strainer.
3. 1/4 turn stops.
4. Flexible supplies.
5. Carrier:
   a. Manufacturers:
      1. JOSAM Company; ______: www.josam.com/#sle.

2.05 SINKS

A. Sink Manufacturers:

B. Single Compartment Bowl: ASME A112.19.3; _____ by _____ by _____ inch outside dimensions 20 gage, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
   1. Drain: 1-1/2 inch chromed brass drain.

C. Double Compartment Bowl: ASME A112.19.3; _____ by _____ by _____ inch outside dimensions 20 gage, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
   1. Drain: 1-1/2 inch chromed brass drain.

2.06 SHOWERS

A. Shower Manufacturers:
   2. Delta Faucet Company

B. Shower Valve:
   1. Comply with ASME A112.18.1.
   2. Provide two handle in wall diverter valve body with integral thermostatic mixing valve to supply 2.0 gpm.

C. Shower Head:

D. Low-Flow Shower Head:
   1. ASME A112.18.1; chrome plated vandal-proof institutional head with integral wall bracket, built-in 2.0 gpm flow control.

E. Hand-Held Shower Head:
   1. ASME A112.18.1, adjustable spray hand-held shower head with swivel fitting, with ASSE 1014 backflow preventer.
   2. Include 60 inch minimum flexible polished stainless steel hose and in-line vacuum breaker
   3. Provide 25 inch grab bar with sliding spray holder that locks at any height, allowing use of unit as either a hand-held spray or a fixed shower head.
2.07 ELECTRIC WATER COOLERS

A. Electric Water Cooler Manufacturers:

B. Water Cooler: Electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.
   1. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
   2. Electrical: 115 V, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

2.08 EMERGENCY EYE AND FACE WASH

A. Emergency Wash: ANSI Z358.1; wall-mounted, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor, twin eye wash heads and face spray ring, stainless steel dust cover, copper alloy control valve and fittings.

2.09 EMERGENCY SHOWERS

A. Emergency Shower: ANSI Z358.1; wall-mounted, self-cleaning, non-clogging 8 inch diameter stainless steel deluge shower head with elbow, one inch full flow valve with pull chain and 8 inch diameter ring, one inch interconnecting fittings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.
B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports and bolts.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

A. Clean plumbing fixtures and equipment.

3.07 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.

B. Do not permit use of fixtures by construction personnel.

C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
SECTION 23 01 30 - BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL CONDITIONS

A. The General Conditions of the Contract and Supplementary Conditions of the General Contract apply to work under this Division.

1.02 QUALITY ASSURANCE

A. If manufacturer's material or equipment is listed in Schedules or on Drawings, they are types to be provided for establishment of size, capacity, grade, and quality. If other acceptable manufacturers are used, cost of any change in construction required by their use shall be borne by Contractor.

B. Equipment shall conform to State and/or local Energy Conservation Standards.

C. Execute and test all work per Underwriters, state and local codes, rules, and regulations applicable to trade affected. Included are recommendations of NFPA, SMACNA, OSHA, and ASHRAE. References to standards are latest revision of standard specified.

D. Comply with rules and regulations of local utility companies. Include cost of valves, valve boxes, meter boxes, meters, accessory equipment required for project.

1.03 INTENT AND INTERPRETATIONS

A. It is the intent of these Drawings and Specifications to result in a complete mechanical installation in complete accordance with all applicable codes and ordinances.

B. Drawings are diagrammatic in character and do not necessarily indicate every required pipe, offset, transition, etc. Items not specifically mentioned in the Specification or noted on the Drawings, but which are obviously necessary to make a complete working installation, shall be included.

C. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. If there is a conflict in the Contract Documents, the more demanding and costly design shall be selected for bidding purposes. The Contractor shall immediately present the conflict found in the Contract Documents to the Architect/Engineer for resolution. If the resolution favors a less costly design, the Contractor will be required to reimburse the difference in cost.

D. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurements, take the necessary measurements and prepare the drawings.

E. Symbols used on the Drawings are defined in the Legend on the Drawings. All symbols indicated on the Legend may not necessarily be required for the project.

F. "Provide" shall mean "furnish and install." "Accepted" or "acceptable" denotes that the work or equipment item is in conformance with the design concept of the project and, in general, complies with the pertinent information given in the Contract Documents.
G. Prior to ordering equipment, determine that equipment will adequately pass through building openings and passageways providing unobstructed access to final equipment location. Equipment shall be manufactured and shipped in sections for assembly in final equipment location when inadequate building openings and passageways limit access. Shop drawings and submittals shall indicate sectionalized manufacturing of equipment.

H. Before any work is installed, determine that equipment will properly fit the space, that required clearances can be maintained and that equipment can be located without interferences between systems, with structural elements, or with the work of other trades.

I. If conflicts are discovered in Contract Documents as work progresses, submit a set of drawings marked with red pencil showing recommended modifications to the Architect for approval prior to installation.

J. The Drawings indicate the general arrangement of mechanical systems. However, rearrangement will not be permitted without specific approval prior to installation.

K. Provide incidental equipment such as tools, scaffolding, consumable items, testing equipment, appliances and the like whether listed or not. Provide labor, fees, licenses, start-up and checkout services also.

L. If any discrepancies of any kind exist or required items or details have been omitted, notify the Architect in writing of such discrepancy or omission at least five days prior to bid date. Failure to do so shall be construed as willingness to supply all necessary materials and labor required for the proper completion of this work.

1.04 JOB CONDITIONS

A. Location, size, and type of equipment and material shown as existing is taken from existing drawings. Verify exact conditions in field prior to start of construction.

B. Before submitting bid, examine premises and become familiar with all existing conditions which may affect cost. No allowance will subsequently be made for not following this procedure.

C. Owner-furnished existing equipment will be installed at new site. Become familiar with existing rough-in requirements prior to installation. Report any difficulties or discrepancies to Architect prior to start of work.

D. Not all piping and ductwork offsets, transitions, and multiple connections required to install the new work into the available space are shown on the drawings. Field measure for exact requirements and install accordingly.
   1. Confer, cooperate, and coordinate work with other trades. Coordinate ceiling cavity space carefully with all trades.

E. Where locations of devices and equipment are not specifically mentioned in the Specifications or indicated on the Drawings, verify locations with Architect or Owner prior to rough-in.

F. Submit large scale coordinated composite layouts showing both plan and elevation, piping, ducts, and conduits in areas that appear congested. Check routing of work prior to fabrication. Report conflicts to Architect.

G. Provide carpentry, masonry, concrete and metal work required for work of this Division where not
specifically called for under other Sections.

H. Complete all work necessary to meet requirements without additional expense to Owner.

1.05 PERMITS AND FEES

A. Arrange and pay for all inspections, permits, licenses, certificates, and fees required in connection with work.

1.06 SUBMITTALS AND SHOP DRAWINGS

A. Conform to requirements of Division 1 and following paragraphs.

B. Submittals shall include catalog cut-sheets, manufacturer's data sheets, written descriptions, and specification sheets detailing the associated product, item, and assembly.

C. Shop drawings shall include details, installation drawings, assembly drawings, fabrication drawings, diagrams, and other information which show adaptation or installation of Contractor-furnished products or materials for overall project.

D. Prior to ordering equipment or beginning installation work, assemble, prepare, and furnish submittals and shop drawings required for project. Furnish submittals and shop drawings as required by individual sections of specifications.

E. Contractor shall thoroughly check subcontractors' or vendors' submittals and shop drawings and, after approving them, submit them for review. Submittals and shop drawings that do not bear Contractor's review stamp will be returned Not Reviewed.

F. The purpose of submittals and shop drawings is to ensure that Contractor understands design requirements and demonstrates understanding by indicating and detailing intended materials, methods, and installation practices. Submittals and shop drawings are not a method of requesting substitutions or deviation from Specifications. If discrepancies between submittals, shop drawings, and Contract Documents are discovered either prior to or after submittals and shop drawings are reviewed, requirements of Contract Documents shall take precedence. Submittals and shop drawings which are submitted, but which are not required by Contract Documents, will be returned Not Reviewed.

G. Review of submittals and shop drawings and action recommended as result of review is courtesy extended to Contractor by Owner's representative. This review is intended to minimize delivery to job site and installation of materials and equipment that do not meet intent of Construction Documents. Submission of material for review does not alter Contractor's obligation to follow intent of Construction Documents, nor Contractor's responsibility to comply therewith.

H. Submittals and shop drawings shall identify specific equipment with numbers or letters identical to those listed or scheduled on the Drawings or Specifications.

I. Each set of submittals and shop drawings submitted or re-submitted shall bear a unique Contractor's submittal number. Submit as required by Division 1. After review, submittals and shop drawings will be returned together with Submittal Review Sheet which indicates comments on submittals and shop drawings and with specific actions such as: No Exception Taken; Make Corrections Noted, Re-submittal Not Required; Make Corrections Noted, Re-submittal Required; Rejected; Not Reviewed. Continue to re-submit submittals and shop drawings until No Exception Taken or Make Corrections Noted, Re-submittal Not Required action is indicated.
1.07 RECORD DOCUMENTS

A. Keep in custody during entire period of construction, a current set of documents indicating changes that have been made to the Contract Documents. Changes to be noted on the documents shall include but shall not be limited to piping or ductwork location more than 2'-0” from where shown on Drawings, changes in pipe and duct size, location of valves and cleanouts. Mark valve tag numbers on Drawings. Incorporate Addenda, accepted Alternates, Change Orders, and other Document revisions which occurred after the award of the General Contract or the start of construction activities into the Record Documents. Notations and changes shall be done in a neat and legible manner in accordance with [Architect’s] [Engineer’s] instructions. Changes shall be noted in red, deletions in green, and notes in blue.

B. Upon completion of work, submit the complete set of Record Documents to the Architect. The Contract Documents set the standard for content and methods of presentation for the changes shown.

C. The Contract shall not be considered completed until these Record Documents have been reviewed and accepted by the Architect.

1.08 DELIVERY, STORAGE, HANDLING

A. Provide delivery and safe storage of materials and equipment. Make provisions for introduction into building of equipment too large to pass through finished openings. Provide for hoisting of equipment.

1.09 PROTECTION OF EQUIPMENT

A. Protect materials and equipment from physical damage, construction dirt, and the elements from time of shipment to time installation is accepted by Owner.

B. Protect mechanical work against theft, injury, or damage from all causes.

1.10 GUARANTEE

A. Guarantee materials, workmanship, and operation of equipment installed for period of one year from date of acceptance of entire Work. Repair or replace any part of work which shows defect during that time.

B. Be responsible for damage to property of Owner or to work of other contractors during construction and guarantee period.

C. Furnish equipment warranties to Owner.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 HANDLING OF EQUIPMENT USING REFRIGERANTS
A. Technicians handling equipment with refrigerants, for removal or installation, shall be EPA (Environmental Protection Agency) certified in accordance with Regulation No. 15 of Colorado Air Quality Control Commission, Section 608 of the Clean Air Act, 1990, as amended.

B. Type of technician certification shall be compatible with the handled equipment: high, very high, or low pressure appliances.

C. Equipment to be removed shall be evacuated of refrigerant to the pressures established in the Prohibition of Venting Table of Section 608 for the type of refrigerant handled. Evacuation equipment shall be certified in accordance with ARI 740.

D. Evacuated refrigerant shall be recovered and recycled in accordance with EPA’s requirements at the Contractor’s expense.

E. Prior to handling of equipment with refrigerants, submit proof of technical and refrigerant handling equipment certification. After handling of refrigerants, submit detailed documentation, including type of refrigerant and quantities, indicating the steps taken to comply with EPA regulations.

3.02 MECHANICAL EQUIPMENT WIRING AND CONNECTIONS

A. Voltage characteristics shall be as in Electrical Division of Specifications and on Electrical Drawings.

3.03 DEMOLITION

A. During demolition, carefully remove existing equipment, piping, ductwork, and related items as required for Work. Tag items, protect from damage, and store as directed by Owner. Deliver list of items stored to Owner. At completion of work or when directed by Architect, remove from job site stored items not reused or wanted by Owner.

B. Hazardous material may exist at job site. If hazardous material is discovered, stop work in that area, notify Architect. Owner will remove hazardous material. Do not resume work in that area until notified to do so by Owner.

C. Dispose of or recycle refrigerant and refrigeration equipment in accordance with State and Federal regulations.

3.04 EXCAVATING AND BACKFILLING

A. Have all underground utilities located and marked before excavating. Instruct employees on markings and color codes and train employees on excavation and safety procedures for natural gas lines. When excavation approaches gas lines, expose lines by carefully probing and hand digging.

B. Do excavating, backfilling, and compacting per Division 2.

C. Walls of trenches shall be minimum 6” from side of nearest mechanical work. Install pipes with minimum 6" clearance between when located in same trench.

D. Pipe Trenching: Dig trenches to depth, width, configuration, and grade appropriate to piping being installed. Dig trenches to 6” below level of bottom of pipe to be installed. Install 6” bed of pea gravel or fine granular material, mechanically tamp to firm bed for piping, true to line and grade. Provide depressions only at hubs, couplings, flanges, or other normal pipe protrusions.
E. Do not backfill until work has been inspected, tested, approved. Backfill material shall be approved by Architect. Do not bury lumber, metal, or other debris with backfill.

F. Trench Backfill: Backfill to 12” above top of piping with pea gravel or fine granular material. Compact properly. Continue backfill to finish grade in 6” layers, each properly moistened and mechanically compacted. Do not compact by hydraulic jetting. Settling shall be refilled, tamped, refinished.

G. Use suitable excavated material to complete backfill.

H. Repair any damage to finished surfaces.

3.05 CUTTING AND PATCHING

A. Locate all holes and chases required for work during progress of construction; provide properly sized metal sleeves or wood boxes for sleeving. Before beginning sleeving or installation work, study Contract Drawings and check piping, ductwork, equipment locations for interference with other trades. If conflicts are discovered, submit recommended solution for approval prior to installation. Do all cutting, repairing, structural reinforcing for installation of work per Architect's directions. Do not cut for any reason without Architect’s approval.

B. Sleeves and chases are prohibited in any structural member except where approved by Architect.

C. Cut and patch all openings in existing walls, floors, and roof as required for ductwork and piping. Patching consists of completing work to match and blend in with adjoining existing work. Patches which are not properly blended shall be redone. Do patching work with craftsmen qualified and skilled in type of patching work required.

3.06 TEMPORARY FACILITIES

A. Light, Heat, Power, Etc.: Provide temporary power supply or other facilities required for Work. Arrange with proper parties to bring facilities from services to required location on premises.

B. Use of Existing Equipment for Temporary Heating or Cooling: Do not use new or existing building equipment without written permission from Owner. If building equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer’s instructions and protected with filters, strainers, controls, reliefs, etc. Guarantee period shall not start until equipment is accepted by Owner.

3.07 INSPECTIONS

A. Do not cover up or enclose work until inspected, tested, and approved. Any work enclosed or covered up before such approval shall be uncovered, tested, and approved.

3.08 ACCESS DOORS

A. Furnish hinged steel access doors with concealed latch, whether shown or not, in walls and plaster or gypsum board ceilings for access to concealed valves, shock arresters, air vents, motors, fans, balancing valves, or other operating devices requiring adjustment or servicing.

B. Access door shall be size of equipment to be removed or 24” by 24” if used for service only.
C. Furnish doors to trades performing work in which they are to be installed. Group valves, devices, and other equipment, to permit use of minimum number of access doors.

D. Doors shall be type compatible with finish in which they are to be installed.

3.09 SUPERVISION

A. Supervise work to proceed in proper sequence without delay to other contractors. Keep supervisor on premises at all times to ensure that intent of Drawings and Specifications is being followed.

3.10 INSTALLATION

A. Workmanship shall be first quality. Appearance of work shall be of equal importance to its mechanical operation. Lack of quality workmanship shall be reason for rejection of system in part or in whole.

B. Install so that all valves and equipment can be easily accessed and serviced by adequate clearance, installation of access doors, unions in piping, or other methods.

C. Complete installation shall function smoothly and noiselessly.

D. Install equipment and materials per manufacturers' recommendations and local codes or regulations.

E. Place or replace all equipment nameplates where they can be seen and read without difficulty.

F. Flush pipes free of foreign substances before installing valves or making final connections. Clean all piping and equipment.

3.11 LUBRICATION OF EQUIPMENT

A. Lubricate equipment before operating and before turning over to Owner.

3.12 TESTING

A. All tests specified herein and/or called for by authorities having jurisdiction shall be witnessed by Architect or Owner.

B. Upon completion of the work, deliver certificates of inspection and final approval to Owner.

3.13 SYSTEM START-UP AND TESTING

A. Start up and test all equipment per manufacturer's instructions. Operate system to establish proper operation and performance. Make necessary adjustments and corrections.

B. Certify to Owner in writing that system has been operated and tested and is operating to design performance requirements.

3.14 COMPLETION

A. Clean insulation covering, ducts, pipes, equipment, and accessories to receive prime coat of paint. Clean equipment received with prime coat to receive final coat.
B. Replace air filters if units were operated during construction. Clean ducts, blowers, and coils if units were operated without filters during construction. Provide 1 complete set of HVAC filters for all equipment that requires filters.

C. Instruct Owner in operation and maintenance of mechanical systems. Minimum participants shall include mechanical contractor and controls contractor representatives.

D. After tests and adjustments have been made and systems pronounced satisfactory for permanent operation, refinish damaged finish and leave everything in proper working order and appearance.

E. On completion of work, remove tools, scaffolding, debris, etc., from grounds and leave premises clean.

F. Provide 1 set of Belts for all HVAC equipment that requires Belts.

3.15 PROJECT CLOSE-OUT

A. Upon written notice from the Contractor certifying that the work is complete and ready for inspection, Engineer will prepare punchlist of items determined to be incomplete or otherwise not in compliance with intent of Contract Documents.

B. When required, subsequent visit to review completion of punchlist work will be made after receipt of written statement from Contractor indicating punchlist work is complete. Include copies of intermediate observation reports and final punchlists with individual items initialed by Contractor to attest that individual work items are completed.

C. Contractor shall pay Engineer's costs at the billing rates in effect at the time the services are performed for subsequent punch list visits required due to lack of completion of prior punch list.

3.16 OPERATION AND MAINTENANCE MANUALS

A. Prior to completion of project, submit three (3) sets of maintenance manuals covering operation and maintenance of mechanical equipment with moving or movable parts, including plumbing systems. Instructions shall be in pamphlet or typewritten form in three ring binders. Instructions for each unit shall be indicated by separate tab.

B. Include test and balance report.

C. Include valve tag list.

D. Include name, address, telephone number of party to be contacted for 24-hour service for each item of equipment.

E. Include starting, stopping, lubrication, preventative maintenance schedule, and adjustment information for each piece of equipment.

F. Include guarantees and warranties of all equipment.

END OF SECTION
SECTION 23 0517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   
   A. Pipe sleeves.
   
   B. Manufactured sleeve-seal systems.

1.02 RELATED REQUIREMENTS
   
   A. Section 07 8400 - Firestopping.
   
   B. Section 23 0523 - General-Duty Valves for HVAC Piping.
   
   C. Section 23 0719 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS
   
   A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2016.
   

PART 2 PRODUCTS

2.01 PIPE SLEEVES
   
   A. Vertical Piping:
      
      1. Sleeve Length: 1 inch above finished floor.
      
      2. Provide sealant for watertight joint.
   
   B. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
   
   C. Clearances:
      
      1. Provide allowance for insulated piping.
      
      2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
      
      3. All Rated Openings: Caulked tight with fire stopping material conforming to ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS
   
   A. Modular/Mechanical Seal:
      
      1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
      
      2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.

4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

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

D. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

1. Aboveground Piping:
   a. Pack solid using mineral fiber conforming to ASTM C592.
   b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.

2. All Rated Openings: Caulk tight with fire stopping material conforming to ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

E. Manufactured Sleeve-Seal Systems:

1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.

2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.

3. Locate piping in center of sleeve or penetration.

4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.

5. Tighten bolting for a water-tight seal.

6. Install in accordance with manufacturer's recommendations.

F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

END OF SECTION
SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Flow meters.
   B. Pressure gages and pressure gage taps.
   C. Thermometers and thermometer wells.
   D. Static pressure gages.

1.02 RELATED REQUIREMENTS
   A. Section 23 0923 - Direct-Digital Control System for HVAC.
   B. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS
   A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
   E. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.01 LIQUID FLOW METERS
   A. Calibrated ASME MFC-3M Venturi orifice plate and flanges with valved taps, chart for conversion of differential pressure readings to flow rate, with pressure gauge in case.
   B. Annular element flow stations with meter set.
      1. Measuring Station: Type 316 stainless steel pitot type flow element inserted through welded threaded couplet, with safety shut-off valves and quick coupling connections, and permanent metal tag indicating design flow rate, reading for design flow rate, metered fluid, line size, station or location number.

2.02 PRESSURE GAGES
   A. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
1. Case: Steel with brass bourdon tube.
2. Size: 4-1/2 inch diameter.
3. Mid-Scale Accuracy: One percent.
4. Scale: Psi and KPa.

2.03 PRESSURE GAGE TAPPINGS
   A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.
   B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
   C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
   D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.04 STEM TYPE THERMOMETERS
   A. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
      1. Size: 9 inch scale.
      2. Window: Clear Lexan.
      4. Accuracy: 2 percent, per ASTM E77.
      5. Calibration: Degrees F.

2.05 THERMOMETER SUPPORTS
   A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.06 TEST PLUGS
   A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.

2.07 STATIC PRESSURE GAGES
   A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
   B. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.

C. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gauge. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

E. Provide instruments with scale ranges selected according to service with largest appropriate scale.

F. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

G. Locate test plugs adjacent thermometers and thermometer sockets.

3.02 SCHEDULE

A. Flow Meters, Location:
   1. Heating water system.

B. Pressure Gages, Location and Scale Range:
   1. Pumps, 0 to _____ psi.
   2. Expansion tanks, 0 to _____ psi.
   3. Pressure reducing valves, 0 to _____ psi.
   4. Backflow preventers, 0 to _____ psi.

C. Pressure Gage Tappings, Location:
   2. Boiler - inlets and outlets.

D. Stem Type Thermometers, Location and Scale Range:
   1. Headers to central equipment, 0 to _____ degrees F.
   2. Boilers - inlets and outlets, 0 to _____ degrees F.

E. Static Pressure and Filter Gages, Location and Scale Range:
   1. Supply fan discharge, 0 to _____ inches W.C.
2. Building static, 0 to _____ inches W.C..

END OF SECTION
SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Applications.
B. General requirements.
C. Ball valves.
D. Butterfly valves.
E. Check valves.

1.02  RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels.
B. Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
C. Section 23 0553 - Identification for HVAC Piping and Equipment.
D. Section 23 0719 - HVAC Piping Insulation.
E. Section 23 2113 - Hydronic Piping.

1.03  ABBREVIATIONS AND ACRONYMS

A. CWP:  Cold working pressure.
B. EPDM:  Ethylene propylene copolymer rubber.
C. NRS:  Nonrising stem.
D. PTFE:  Polytetrafluoroethylene.

1.04  REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
E. ASME B31.9 - Building Services Piping; 2014.
J. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.
K. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Provide the following valves for the applications if not indicated on Drawings:
   1. Throttling (Hydronic): Butterfly and Ball.
   2. Isolation (Shutoff): Butterfly and Ball.
   3. Swing Check (Pump Outlet):
      a. 2 NPS and Smaller: Bronze with bronze disc.
      b. 2-1/2 NPS and Larger: Iron with center-guided with resilient seat.

B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

C. Required Valve End Connections for Non-Wafer Types:
   1. Steel Pipe:
      a. 2 NPS and Smaller: Threaded ends.
      b. 2-1/2 NPS and Larger: Grooved ends.
   2. Copper Tube:
      a. 2 NPS and Smaller: Threaded ends (Exception: Solder-joint valve-ends).
      b. 2-1/2 NPS and Larger: Grooved ends.

D. Heating Hot Water Valves:
   1. 2 NPS and Smaller, Brass and Bronze Valves:
      a. Threaded ends.
2. Ball: Full port, one piece, brass trim.

2. 2-1/2 NPS and Larger, Iron Valves:
   a. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
   b. Center-Guided Check: Compact-wafer, metal seat, Class 125.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Hand Lever: Quarter-turn valves 6 NPS and smaller ______________.

D. Valves in Insulated Piping: Provide 2 NPS stem extensions and the following features:
   1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

E. Memory Stops: Fully adjustable after insulation is installed.

F. Valve-End Connections:

G. General ASME Compliance:

H. Bronze Valves:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

I. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRASS BALL VALVES

A. Two Piece, Full Port with Stainless Steel Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
5. Ends: Threaded.
6. Seats: PTFE or PTFE or TFE.
7. Stem: Stainless Steel.
8. Ball: Chrome-plated brass.

2.04 BRONZE BALL VALVES

A. Two Piece, Full Port with Bronze or Brass Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 150 psig.
   3. CWP Rating: 600 psig.
   5. Ends: Threaded.
   6. Seats: PTFE.
   7. Stem: Bronze or brass.
   8. Ball: Chrome-plated brass.

2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug type: Bi-directional dead end service without downstream flange.
   1. Comply with MSS SP-67, Type I.
   2. CWP Rating: 150 psig.
   4. Stem: One or two-piece stainless steel.
   5. Seat: NBR.
   6. Disc: Coated ductile iron.

2.06 BRONZE SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig (1380 kPa).
   1. Comply with MSS SP-80, Type 3.
   2. Body Design: Horizontal flow.
   4. Ends: Threaded.
5. Disc: Bronze.

2.07 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Compact-Wafer:
   1. Comply with MSS SP-125.
   2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
   4. Resilient Seat: EPDM.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

D. Install check valves where necessary to maintain direction of flow as follows:
   1. Orient center-guided into horizontal or vertical position, between flanges.

END OF SECTION
SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Nameplates.
B. Tags.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS
A. Air Handling Units: Nameplates.
B. Small-sized Equipment: Tags.

2.02 NAMEPLATES
A. Manufacturers:
C. Letter Height: 1/4 inch.
D. Background Color: Black.
E. Plastic: Conform to ASTM D709.

2.03 TAGS
A. Manufacturers:
PART 3 EXECUTION

3.01 PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION
A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

END OF SECTION
SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

1.02  REFERENCE STANDARDS


1.03  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      d. Final test report forms to be used.
      e. Procedures for formal deficiency reports, including scope, frequency and distribution.

C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Revise TAB plan to reflect actual procedures and submit as part of final report.
   2. Submit draft copies of report for review prior to final acceptance of Project.
      Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS
A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
C. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of three years documented experience.
   3. Certified by one of the following:
D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION
A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
  10. Air outlets are installed and connected.
  11. Duct system leakage is minimized.
  12. Service and balance valves are open.
B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
3.03  **PREPARATION**

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

C. Provide additional balancing devices as required.

3.04  **ADJUSTMENT TOLERANCES**

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.05  **RECORDING AND ADJUSTING**

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06  **AIR SYSTEM PROCEDURE**

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

J. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

K. On fan powered VAV boxes, adjust air flow switches for proper operation.

END OF SECTION
SECTION 23 07 13 - DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.
B. Duct liner.
C. Insulation jackets.

1.02 REFERENCE STANDARDS

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS
A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE
A. Manufacturer:
B. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 1200 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.
C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure sensitive tape.
D. Tie Wire: Annealed steel, 16 gage, 0.0508 inch diameter.

2.03 JACKETS
   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.04 DUCT LINER

A. Manufacturers:
   1. Armacell LLC; AP Coilflex: www.armacell.us/#sle.

B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 180 degrees F.

C. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
   1. Fungal Resistance: No growth when tested according to ASTM G21.
   2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
   3. Service Temperature: Up to 250 degrees F.
   4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
   5. Minimum Noise Reduction Coefficients:
      a. 1 inch Thickness: 0.45.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated ducts conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ducts conveying air above ambient temperature:
1. Provide with or without standard vapor barrier jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

END OF SECTION
SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.
B. Flexible removable and reusable blanket insulation.
C. Jackets and accessories.

1.02 REFERENCE STANDARDS

B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
C. Manufacturer’s Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 FIELD CONDITIONS
   A. Maintain ambient conditions required by manufacturers of each product.
   B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS
   A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER
   A. Manufacturers:
   B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
      1. ‘K’ Value: ASTM C177, 0.24 at 75 degrees F.
      2. Maximum Service Temperature: 850 degrees F.
      3. Maximum Moisture Absorption: 0.2 percent by volume.
   C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

2.03 JACKETS
      1. Thickness: 0.016 inch sheet.
      2. Finish: Smooth.
4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
C. Glass fiber insulated pipes conveying fluids above ambient temperature.
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

END OF SECTION
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SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1  GENERAL

1.01  SUMMARY

A. See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.

B. This section covers the Contractor’s responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor’s use.

D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
   1. Control system.
   2. Major and minor equipment items.
   3. Piping systems and equipment.
   4. Terminal units.
   5. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02  RELATED REQUIREMENTS

A. Section 01 9113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

B. Section 23 0923 - Direct-Digital Control System for HVAC.

C. Section 23 0913 - Instruments and Control Elements.

D. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.

1.03  REFERENCE STANDARDS


1.04  SUBMITTALS

A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
**B. DRAFT Prefunctional Checklists and Functional Test Procedures for Control System:**

Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:

1. System name.
2. List of devices.
3. Step-by-step procedures for testing each controller after installation, including:
   a. Process of verifying proper hardware and wiring installation.
   b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
   c. Process of performing operational checks of each controlled component.
   d. Plan and process for calibrating valve and damper actuators and all sensors.
   e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.
5. Description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.

**C. Startup Reports, Prefunctional Checklists, and Trend Logs:** Submit for approval of Commissioning Authority.

**D. HVAC Control System O&M Manual Requirements.** In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:

1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
2. Full as-built set of control drawings.
3. Full as-built sequence of operations for each piece of equipment.
4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
   a. Floor.
   b. Room number.
   c. Room name.
   d. Air handler unit ID.
   e. Reference drawing number.
   f. Air terminal unit tag ID.
   g. Heating and/or cooling valve tag ID.
   h. Minimum air flow rate.
   i. Maximum air flow rate.
5. Full print out of all schedules and set points after testing and acceptance of the system.
6. Full as-built print out of software program.
7. Electronic copy on disk of the entire program for this facility.
8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
10. Control equipment component submittals, parts lists, etc.
11. Warranty requirements.
12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
   a. Sequences of operation.
   b. Control drawings.
   c. Points lists.
   d. Controller and/or module data.
   e. Thermostats and timers.
   f. Sensors and DP switches.
   g. Valves and valve actuators.
   h. Dampers and damper actuators.
   i. Program setups (software program printouts).
E. Project Record Documents: See Section 01 7800 for additional requirements.
   1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
   2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
F. Draft Training Plan: In addition to requirements specified in Section 01 7900, include:
   1. Follow the recommendations of ASHRAE Guideline 1.1.
   2. Control system manufacturer's recommended training.
   3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
G. Training Manuals: See Section 01 7900 for additional requirements.
   1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.
PART 3 EXECUTION

3.01 PREPARATION

A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Authority.

C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.

D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

1. Include cost of sheaves and belts that may be required for testing, adjusting, and balancing.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.

G. Provide temperature and pressure taps in accordance with the contract documents.

1. Provide a pressure/temperature plug at each water sensor that is an input point to the control system.

3.02 INSPECTING AND TESTING – GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Valve/Damper Stroke Setup and Check:

1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
2. Set pump/fan to normal operating mode.
3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
4. Command valve/damper open; verify position is full open and adjust output signal as required.
5. Command valve/damper to a few intermediate positions.
6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
7. Closure for Heating Coil Valves - Normally Open:
   a. Set heating setpoint 20 degrees F above room temperature.
   b. Observe valve open.
c. Remove control air or power from the valve and verify that the valve stem and actuator position do not change.
d. Restore to normal.
e. Set heating setpoint to 20 degrees F below room temperature.
f. Observe the valve close.
g. Restore to normal.

E. Coil Valve Leak Check:
1. Method 2 - Air Temperature With 2 or 3-Way Valve: Water leak-by less than 10 percent will likely not be detected with this method.
a. Calibrate air temperature sensors on each side of coil to be within 0.2 degree F of each other.
b. Air handler fans should be on.
c. Change mixed or discharge air setpoint, override values or bleed or squeeze bulb pneumatic controller to cause the valve to close.
d. After 5 minutes observe air delta T across coil. If it is greater than one degree F, leakage is probably occurring.
e. Reset valve stroke to close tighter.
f. Repeat test until compliance is achieved.

F. Isolation Valve or System Valve Leak Check: For valves not by coils.
1. With full pressure in the system, command valve closed.
2. Use an ultra-sonic flow meter to detect flow or leakage.

G. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing of HVAC.
B. Coordinate commissioning schedule with TAB schedule.
C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.
F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of the Contract Documents and the detailed Sequences of Operation documentation submittal.
B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with the contract documents.
C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.

D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
   1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
   2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.

E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

G. Demonstrate to the Commissioning Authority:
   1. That all specified functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and setup, including holidays.
   3. That all graphic screens and value readouts are completed.
   4. Correct date and time setting in central computer.
   5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
   6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
   7. Power failure and battery backup and power-up restart functions.
   8. Global commands features.
   9. Security and access codes.
   10. Occupant over-rides (manual, telephone, key, keypad, etc.).
   11. O&M schedules and alarms.
   12. Occupancy sensors and controls.
   13. All control strategies and sequences not tested during controlled equipment testing.

H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

A. See Section 01 7800 for additional requirements.

B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 01 7900 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.

D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:

E. TAB Review: Instruct Owner's personnel for minimum ____ hours, after completion of TAB, on the following:
   1. Review final TAB report, explaining the layout and meanings of each data type.
   2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
   3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
   4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
   5. Other salient information that may be useful for facility operations, relative to TAB.

F. HVAC Control System Training: Perform training in at least three phases:
   1. Phase 1 - Basic Control System: Provide minimum of ____ hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
      a. This training may be held on-site or at the manufacturer's facility.
      b. If held off-site, the training may occur prior to final completion of the system installation.
      c. For off-site training, Contractor shall pay expenses of up to two attendees.
   2. Phase 2 - Integrating with HVAC Systems: Provide minimum of ____ hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
      a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
      b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
      c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically
and printing trends; provide practice in setting up trend logging and monitoring during training session.
d. Every display screen, allowing time for questions.
e. Point database entry and modifications.
3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of _____ hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.

G. Provide the services of manufacturer representatives to assist instructors where necessary.
H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION
SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. DDC system to be accessible through Districts existing Honeywell Building Controls extended architecture system (IP).

1.02 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.03 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. MS/TP: Master slave/token passing.

D. PC: Personal computer.

E. PID: Proportional plus integral plus derivative.

1.04 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. **Alarm Response Time**: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. **Program Execution Frequency**: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. **Performance**: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. **Reporting Accuracy and Stability of Control**: Report values and maintain measured variables within tolerances as follows:

   a. Water Temperature: Plus or minus 1 deg F.
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F.
   e. Ducted Air Temperature: Plus or minus 1 deg F.
   f. Outside Air Temperature: Plus or minus 2 deg F.
   g. Dew Point Temperature: Plus or minus 3 deg F.
   h. Temperature Differential: Plus or minus 0.25 deg F.
   i. Relative Humidity: Plus or minus 5 percent.
   j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
   k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   l. Airflow (Terminal): Plus or minus 10 percent of full scale.
   m. Air Pressure (Space): Plus or minus 0.01-inch wg.
   n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
   o. Electrical: Plus or minus 5 percent of reading.

**1.05 ACTION SUBMITTALS**

A. **Product Data**: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

   1. **DDC System Hardware**: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

   2. **Control System Software**: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

   3. **Controlled Systems**: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. **Shop Drawings**: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Schedule of dampers including size, leakage, and flow characteristics.
6. Schedule of valves including flow characteristics.
7. DDC System Hardware:
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams and floor plans for field sensors and control hardware.
   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
9. Controlled Systems:
   a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
   b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
   c. Written description of sequence of operation including schematic diagram.
   d. Points list.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.
1.08 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer’s authorized representative who is trained and approved for installation of system components required for this Project.

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

C. Comply with ASHRAE 135 for DDC system components.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.10 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate equipment with Section 262416 “Panelboards” to achieve compatibility with starter coils and annunciation devices.

PART 2 - PRODUCTS

2.01 CONTROL SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

B. DDC controls manufacturer shall be Honeywell Platform.

C. DDC control vendors: Controls by Honeywell to match District standards.

D. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator
workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.02 DDC EQUIPMENT

A. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
7. Universal I/Os: Provide software selectable binary or analog outputs.

B. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

C. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.03 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.04 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.5 deg F at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer’s standard locking covers.
   a. Set-Point Adjustment: Concealed.
   b. Set-Point Indication: Concealed.
   c. Thermometer: Concealed.
   d. Orientation: Vertical.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. Room Sensor Cover Construction: Manufacturer’s standard locking covers.

1. Set-Point Adjustment: Concealed.
2. Set-Point Indication: Concealed.
3. Thermometer: Concealed.

D. Room sensor accessories include the following:
1. Guards: Locking; heavy-duty, wired or cast – no plastic; mounted on separate base. Provide guards in common areas only.

2.05 THERMOSTATS

A. Electric, solid-state, microcomputer-based room thermostat with remote sensor. Provide S2 type for classrooms and offices and provide S1 type for common areas. Coordinate type and style with District to match existing.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on weekday, Saturday, and Sunday.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

   a. Time of day.
   b. Actual room temperature.
   c. Programmed temperature.
   d. Programmed time.
   e. Duration of timed override.
   f. Day of week.
   g. System mode indications include "heating," "off," "fan auto," and "fan on."

B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.

2.06 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
   e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: Minus 22 to plus 122 deg F.
10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
11. Run Time: 12 seconds open, 5 seconds closed.

2.07 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure independent and temperature rating of piping system, unless otherwise indicated.
B. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
   a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
   b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

C. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

   2. Disc Type: Nickel-plated ductile iron.
   3. Sizing: 1-psig maximum pressure drop at design flow rate.

D. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

   1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
   2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
   3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
2.08 DAMPERS

A. Dampers: AMCA-rated, parallel-blade design; 0.108-inch-minimum thick, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.09 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

3.02 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install automatic dampers according to Section 233300 "Air Duct Accessories."
E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

F. Install labels and nameplates to identify control components according to Section 230515 "Identification for HVAC Piping and Equipment."

G. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."

H. Install duct volume-control dampers according to Section 233113 "Metal Ducts."

3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable as follow and meet all District requirements.
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install concealed cable in raceway.
   4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.04 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:
   1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
   2. Equipment to Be Connected:
      a. Air-terminal units specified in Section 233600 "Air Terminal Units."
b. Boilers specified in Section 235216 "Condensing Boilers."

c. Air-handling units specified in Section 237313 "Modular Indoor Central-Station Air-Handling Units."

3.05 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

A. Interface with Existing Systems:

1. DDC systems shall interface existing systems to achieve integration.

2. Monitoring and Control of DDC System by Existing Control System:
   a. DDC system performance requirements shall be satisfied when monitoring and controlling DDC system by existing control system.
   b. Operator of existing system shall be able to upload, download, monitor, trend, control and program every input and output point in DDC system from existing control system using existing control system software and operator workstations.
   c. Remote monitoring and control from existing control system shall not require operators of existing control system to learn new software.
   d. Interface of DDC system into existing control system shall be transparent to operators of existing control system and allow operators to program, monitor, and control DDC system from any operator workstation connected to existing control system.

3. Integration of Existing Control System into DDC System:

   a. Existing control system performance requirements shall be satisfied when monitoring and controlling existing control system through DDC system.
   b. Operator shall be able to upload, download, monitor, alarm, report, trend, control and program every input and output point in existing system from DDC system using operator workstations and software provided. The combined systems shall share one database.
   c. Interface of existing control system I/O points into DDC system shall be transparent to operators. All operational capabilities shall be identical regardless of whether I/O already exists or I/O is being installed.

3.06 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check instrument tubing for proper fittings, slope, material, and support.
   5. Check installation of air supply for each instrument.
   6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
   7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
   8. Check temperature instruments and material and length of sensing elements.
   9. Check control valves. Verify that they are in correct direction.
  10. Check DDC system as follows:
      a. Verify that DDC controller power supply is from emergency power supply, if applicable.
      b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
      c. Verify that spare I/O capacity has been provided.
      d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.07 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer’s written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Control System Inputs and Outputs:
      a. Check analog inputs at 0, 50, and 100 percent of span.
b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
c. Check digital inputs using jumper wire.
d. Check digital outputs using ohmmeter to test for contact making or breaking.
e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:
   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistant source.
   b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.08 DEMONSTRATION

A. Engage a factory-authorized Honeywell service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training."
SECTION 23 21 13 - HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.
B. Heating water piping, above grade.
C. Heating water and glycol piping, above grade.
D. Equipment drains and overflows.
E. Pipe hangers and supports.
F. Unions, flanges, mechanical couplings, and dielectric connections.
G. Valves:
   1. Ball valves.
   2. Butterfly valves.
   3. Check valves.
H. Flow controls.

1.02 RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels.
B. Section 09 9123 - Interior Painting.
C. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.
D. Section 23 0719 - HVAC Piping Insulation.
E. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.
C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
E. ASME B31.9 - Building Services Piping; 2014.
PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
   1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
   2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
   3. Grooved mechanical joints may be used in accessible locations only.
      a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
      b. Use rigid joints unless otherwise indicated.
   4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated:
1. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
2. For throttling, bypass, or manual flow control services, use ball or butterfly valves.
3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.02 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
   a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
   b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
1. Fittings: ASTM D2466 or D2467, PVC.
2. Joints: Solvent welded in accordance with ASTM D2855.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
11. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Less:
   1. Ferrous Piping: 150 psig malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.
B. Flanges for Pipe 2 Inches and Greater:
   1. Ferrous Piping: 150 psig forged steel, slip-on.
   2. Copper Piping: Bronze.
   3. Gaskets: 1/16 inch thick preformed neoprene.
C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
   1. Dimensions and Testing: In accordance with AWWA C606.
   2. Mechanical Couplings: Comply with ASTM F1476.
   3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
   4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
   5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
   6. When pipe is field grooved, provide coupling manufacturer’s grooving tools.
D. Dielectric Connections:
   1. Waterways:
      a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      b. Dry insulation barrier able to withstand 600 volt breakdown test.
      c. Construct of galvanized steel with threaded end connections to match connecting piping.
      d. Suitable for the required operating pressures and temperatures.
   2. Flanges:
      a. Dielectric flanges with same pressure ratings as standard flanges.
      b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      c. Dry insulation barrier able to withstand 600 volt breakdown test.
      d. Construct of galvanized steel with threaded end connections to match connecting piping.
      e. Suitable for the required operating pressures and temperatures.
2.06 BALL VALVES

A. Up To and Including 2 Inches:
   1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

B. Over 2 Inches:
   1. Ductile iron body, chrome plated stainless steel ball, teflon, Virgin TFE, or _______ seat and stuffing box seals, lever handle, gear operated, or __________, flanged ends, rated to 800 psi.

2.07 BUTTERFLY VALVES

A. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, grooved, or ______ ends, extended neck.

B. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, Buna-N encapsulation, or ________________.

C. Operator: 10 position lever handle.

2.08 SWING CHECK VALVES

A. Up To and Including 2 Inches:
   1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.

B. Over 2 Inches:
   1. Iron body, bronze or ________ trim, stainless steel, bronze, bronze faced rotating, or ______________ swing disc, renewable disc and seat, flanged, grooved, or __________ ends.

2.09 FLOW CONTROLS

A. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.
E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems. Refer to Section 23 2500 for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and to avoid interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Sleeve pipe passing through partitions, walls and floors.

G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified __________.

H. Slope piping and arrange to drain at low points.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 0516.
   1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.

J. Grooved Joints:
   1. Install in accordance with the manufacturer's latest published installation instructions.
   2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.

K. Inserts:
   1. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

L. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Prime coat exposed steel hangers and supports. Refer to Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 0719.

N. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.
O. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

A. Hanger Spacing for Copper Tubing.
1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.

B. Hanger Spacing for Steel Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.

C. Hanger Spacing for Plastic Piping.
1. 1/2 inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
2. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
3. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
4. 1-1/4 inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
5. 1-1/2 inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
6. 2 inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.
7. 3 inches: Maximum span, 7 feet; minimum rod size, 3/8 inch.
8. 4 inches: Maximum span, 8 feet; minimum rod size, 1/2 inch.

END OF SECTION
SECTION 23 21 14 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Expansion tanks.
B. Air vents.
C. Air separators.
D. Strainers.
E. Suction diffusers.
F. Combination pump discharge valves.
G. Pressure-temperature test plugs.
H. Balancing valves.
I. Combination flow controls.
J. Relief valves.
K. Glycol system.

1.02 RELATED REQUIREMENTS

A. Section 23 2113 - Hydronic Piping.
B. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
PART 2  PRODUCTS

2.01  EXPANSION TANKS

A. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.

B. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi.

C. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02  AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

B. Float Type:
   1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.03  AIR SEPARATORS

A. Coalescing Air/Dirt Separators:
   1. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1; for 150 psi operating pressure and 270 degrees F maximum operating temperature; subject to the requirements of the application and the manufacturer’s standard maximum operating conditions.
   2. Coalescing Medium: Provide structured copper, stainless steel, or __________ medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
   3. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to the top of the separator.
   4. Inlet and Outlet Connections: Threaded for 2 NPS and smaller; Class 150 flanged connections for 2-1/2 NPS and larger.
   5. Blowdown Connection: Threaded.

2.04  STRAINERS

A. Size 2 inch and Under:
   1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:
   1. Provide flanged, grooved, or _________ iron body for 175 psi working pressure, Y pattern with 1/16 inch, 3/64 inch, or _____ inch stainless steel perforated screen.
2.05 SUCTION DIFFUSERS

A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.

B. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.06 COMBINATION PUMP DISCHARGE VALVES

A. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.07 PRESSURE-TEMPERATURE TEST PLUGS

A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

B. Application: Use extended length plugs to clear insulated piping.

2.08 COMBINATION FLOW CONTROLS

A. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.

B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

C. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
   1. Accessories: In-line strainer on inlet and ball valve on outlet.

2.09 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.10 PRESSURE INDEPENDENT VALVES

A. Size 2 inch and Smaller:
   1. Provide ball, globe, or style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, connections.
   2. Metal construction materials consist of bronze, brass.
   3. Non-metal construction materials consist of Teflon, EPDM, engineered resin.
B. Size 2.5 inch and Larger:
   1. Provide ball, globe, butterfly, or style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, weld end connections.
   2. Valve body construction materials consist of cast iron, carbon steel, ductile iron.
   3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin.

2.11 GLYCOL SYSTEM

A. Mixing Tank: 55 gallon steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.
B. Storage Tank: Closed type, welded steel constructed, tested and stamped in accordance with ASME BPVC-VIII-1; 100 psi rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tappings for installation of accessories.
C. Expansion Tank: Diaphragm type with vent fitting with air separator, and automatic air vent.
D. Air Pressure Reducing Station: Pressure reducing valve with shut-off valves, strainer, check valve and needle valve bypass.
E. Glycol Solution:
   1. Inhibited ethylene glycol and water solution mixed 50 percent glycol - 50 percent water, suitable for operating temperatures from minus 40 degrees F to 250 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.
B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
C. Provide manual air vents at system high points and as indicated.
D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
F. Provide valved drain and hose connection on strainer blow down connection.
G. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
I. Support pump fittings with floor mounted pipe and flange supports.
J. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
L. Pipe relief valve outlet to nearest floor drain.
M. Clean and flush glycol system before adding glycol solution. Refer to Section 23 2500.
N. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

O. Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION
SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. In-line circulators.
   B. Vertical in-line pumps.

1.02 RELATED REQUIREMENTS
   A. Section 03 3000 - Cast-in-Place Concrete.
   B. Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   C. Section 23 0719 - HVAC Piping Insulation.
   D. Section 23 2113 - Hydronic Piping.
   E. Section 23 2114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.01 HVAC PUMPS - GENERAL
   A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
   B. Minimum Quality Standard: UL 778.
   C. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.
2.02 IN-LINE CIRCULATORS
   A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi maximum working pressure.
   B. Casing: Cast iron, with flanged pump connections.
   C. Impeller: Non-ferrous keyed to shaft.
   D. Bearings: Oil-lubricated bronze sleeve.
   E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.
   F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
   G. Drive: Flexible coupling.

2.03 VERTICAL IN-LINE PUMPS
   A. Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi working pressure.
   B. Casing: Cast iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
   C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
   D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
   E. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.

PART 3 EXECUTION

3.01 PREPARATION
   A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
   C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
   D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
   E. Provide air cock and drain connection on horizontal pump casings.
   F. Provide drains for bases and seals, piped to and discharging into floor drains.
G. Install close-coupled and base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 3000.

H. Lubricate pumps before start-up.

END OF SECTION
SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping.
B. Refrigerant.
C. Moisture and liquid indicators.
D. Valves.
E. Strainers.
F. Filter-driers.

1.02 REFERENCE STANDARDS

A. AHRI 710 - Performance Rating of Liquid-Line Driers; 2009.
B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
D. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011 (Amended 2012).

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.
B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Pipe Supports and Anchors:
   1. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   5. Vertical Support: Steel riser clamp.
   6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.02 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.03 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:
   3. Sporlan, a Division of Parker Hannifin: www.parker.com/#sle.
   4. __________.

B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.
2.04 VALVES

A. Manufacturers:
   4. __________.

2.05 STRAINERS

A. Manufacturers:
   3. Sporlan, a Division of Parker Hannifin: www.parker.com/#sle.

2.06 FILTER-DRIERS

A. Manufacturers:
   1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com/#sle.
   3. Sporlan, a Division of Parker Hannifin: www.parker.com/#sle.

B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.
   1. Connections: As specified for applicable pipe type.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.
B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
C. Install piping to conserve building space and avoid interference with use of space.
D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

END OF SECTION
SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Materials.
   1. System cleaner.
   2. Closed system treatment (water).

B. By-pass (pot) feeder.

C. Solution metering pump.

D. Solution tanks.

PART 2 PRODUCTS

2.01 MATERIALS

A. System Cleaner:
   1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium triopoly phosphate and sodium molybdate.

B. Closed System Treatment (Water):
   1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
   2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium tolytriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
   3. Conductivity enhancers; phosphates or phosphonates.

2.02 BY-PASS (POT) FEEDER

A. 2 quart quick opening cap for working pressure of 175 psi.

2.03 SOLUTION METERING PUMP

A. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.

B. Electrical Characteristics:
   1. Cord and Plug: Provide unit with 6 foot cord and plug for connection to electric wiring system including grounding connector.

2.04 SOLUTION TANKS

A. 30 gallon capacity, polyethylene, self-supporting, 1 gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.
PART 3 EXECUTION

3.01 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
B. Place terminal control valves in open position during cleaning.
C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

A. Concentration:
   1. As recommended by manufacturer.

B. Hot Water Heating Systems:
   1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
   2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
   3. Circulate for 6 hours at design temperatures, then drain.
   4. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect.

D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

E. Remove, clean, and replace strainer screens.

F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.
3.06 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
   1. Provide minimum of two hours of instruction for two people.
   2. Have operation and maintenance data prepared and available for review during training.
   3. Conduct training using actual equipment after treated system has been put into full operation.

END OF SECTION
SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Metal ductwork.

1.02 REFERENCE STANDARDS
   B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
   E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data for duct materials.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES
   A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.
   B. Ducts: Galvanized steel, unless otherwise indicated.
   C. Low Pressure Supply (Heating Systems): 1/2 inch w.g. pressure class, galvanized steel.
   D. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. pressure class, galvanized steel.
E. Medium and High Pressure Supply: 1/2 inch w.g. pressure class, galvanized steel.
F. Return and Relief: 1/2 inch w.g. pressure class, galvanized steel.
G. General Exhaust: 1/2 inch w.g. pressure class, galvanized steel.
H. Outside Air Intake: 1/2 inch w.g. pressure class, galvanized steel.
I. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, fibrous glass.

2.02 MATERIALS
A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
   3. Manufacturers:
C. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.03 DUCTWORK FABRICATION
A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
D. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.04 MANUFACTURED DUCTWORK AND FITTINGS
A. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
   1. Manufacture in accordance with SMACNA (DCS).
   2. Insulation:
      a. Thickness: 1 inch.
      b. Material: Air.
B. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.
1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
2. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
4. Temperature Range: Minus 10 degrees F to 160 degrees F.
5. Manufacturers:

C. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
   1. Manufacturers:
      a. Carlisle HVAC Products; Nexus Flange Connectors with Sealant Pocket:
         www.carlislehvac.com/#sle.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).
B. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

END OF SECTION
SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air turning devices/extractors.
B. Backdraft dampers - metal.
C. Backdraft dampers - fabric.
D. Combination fire and smoke dampers.
E. Duct access doors.
F. Fire dampers.
G. Flexible duct connections.
H. Smoke dampers.
I. Volume control dampers.

1.02 RELATED REQUIREMENTS

A. Section 23 31 00 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).
D. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS
A. Manufacturers:
1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane): www.carlislehvac.com/#sle.
5. Titus HVAC, a brand of Johnson Controls: www.titus-hvac.com/#sle.

B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL
A. Manufacturers:

B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 BACKDRAFT DAMPERS - FABRIC
A. Fabric Backdraft Dampers: Factory-fabricated.
2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
3. Maximum Velocity: 1000 fpm (5 mps) face velocity.
2.04 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
4. NCA, a brand of Metal Industries Inc: www.ncamfg.com/#sle.

B. Multiple Blade Dampers: Fabricate with 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

C. Operators: UL listed and labelled spring return pneumatic type suitable for operation on 0-20 psig instrument air. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.

2.05 DUCT ACCESS DOORS

A. Manufacturers:
1. Acudor Products Inc, a Division of Nelson Industrial Inc: www.acudor.com/#sle.

B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Provide two hinges and two sash locks.
3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.

2.06 FIRE DAMPERS

A. Manufacturers:
4. NCA, a brand of Metal Industries Inc: www.ncamfg.com/#sle.
2.07 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
   2. Metal: 3 inches wide, 24 gage, 0.0239 inch thick galvanized steel.

2.08 SMOKE DAMPERS

2.09 VOLUME CONTROL DAMPERS

A. Manufacturers:
   3. NCA, a brand of Metal Industries Inc: www.ncamfg.com/#sle.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
   1. Manufacturers:

D. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 31 00 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

D. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.

E. Demonstrate re-setting of fire dampers to Owner's representative.

F. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

END OF SECTION
SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof exhausters.
B. Wall exhausters.
C. Cabinet exhaust fans.
D. Ceiling exhaust fans.
E. Inline centrifugal fans.

1.02 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 FIELD CONDITIONS

A. Permanent ventilators may not be used for ventilation during construction.
PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
   D. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
   E. Twin City Fan & Blower: www.tcf.com/#sle.

2.02 POWER VENTILATORS - GENERAL
   A. Manufacturers: 
   B. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
   C. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
   D. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
   E. Fabrication: Conform to AMCA 99.
   F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 ROOF EXHAUSTERS
   A. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
   B. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
   C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.04 WALL EXHAUSTERS
   A. Manufacturers: 

B. Fan Unit: V-belt or direct driven with spun aluminum housing; resiliently mounted motor; 1/2 inch mesh, 0.062 inch thick aluminum wire bird screen.

C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor, and wall mounted multiple speed switch.

D. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

E. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.05 INLINE CENTRIFUGAL FANS

A. Manufacturers:

B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.

C. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Secure wall exhausters with cadmium plated steel lag screws to structure.

C. Extend ducts to wall exhausters into structure. Counterflash duct to wall opening.

D. Install backdraft dampers on inlet to roof and wall exhausters.
E. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION
SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Single-duct terminal units.
   1. Single-duct, constant-volume units.
   2. Single-duct, variable-volume units.

B. Fan-powered units.

1.02  RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration and Seismic Controls for HVAC.

B. Section 23 09 93 - Sequence of Operations for HVAC Controls.

C. Section 23 31 00 - HVAC Ducts and Casings.

D. Section 25 14 00 - Integrated Automation Local Control Units: HVAC controllers.


1.03  REFERENCE STANDARDS

A. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2011 with Addendum 1.

B. ASHRAE Std 130 - Methods of Testing Air Terminal Units; 2016.


F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.


1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 SINGLE-DUCT, VARIABLE-VOLUME and CONSTANT-VOLUME UNITS

A. Manufacturers:
   1. Metalaire, a brand of Metal Industries Inc: www.metalaire.com/#sle.
   5. Titus.

B. General:
   1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
   2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.

C. Unit Casing:
   1. Minimum 22 gage, 0.0299 inch galvanized steel.
   2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
   3. Unit Discharge: Rectangular, with slip-and-drive connections.
   4. Acceptable Liners:
      a. 1/2 inch thick, coated, fibrous-glass complying with ASTM C1071.
         1. Secure with adhesive.
         2. Coat edges exposed to airstream with NFPA 90A approved sealant.
         3. Cover liner with non-porous foil.
      b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

D. Damper Assembly:
1. Heavy-gage, galvanized steel or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
3. Incorporate low leak damper blades for tight airflow shutoff.

E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

F. Electrical Requirements:
   1. Single-point power connection.
   2. Equipment wiring to comply with requirements of NFPA 70.

G. Controls:
   1. Electronic:
      a. Damper Actuator: 24 volt, power closed, spring return open.
      b. Velocity Controller:
         1. Settings for minimum/maximum air volumes, factory-calibrated, and field adjustable at thermostat.
         2. Maintain constant airflow dictated by thermostat to within 5 percent of set point while compensating for inlet static-pressure variations up to 4 inch wg, when tested in accordance with ASHRAE Std 130.
         3. Provide controller with multi-point with velocity sensors located in air inlets and outlet.
      c. Thermostat: Wall-mounted, time-proportional with reheat-coil control including a temperature set-point display in Celsius and Fahrenheit.
   2. Control Sequence:
      a. Suitable for operation with duct pressures between 0.25 and 3.0 inch wg inlet static pressure.
      b. Include factory-mounted and piped, 5-micron filter; and adjustable, velocity-resetting, high-limit control with amplifying relay.
      c. See Section 23 09 93.

2.02 PARRALLEL FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers:
   1. Metalaire, a brand of Metal Industries Inc: www.metalaire.com/#sle.
   5. Titus.

B. General:
   1. Factory-assembled and wired, AHRI 880 (I-P) rated, horizontal fan-powered terminal unit with blower, blower motor, mixing plenum, and primary air damper contained in a single unit housing.
A. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud.

B. Casing: 0.034-inch steel, double wall.
   1. Casing Lining: Adhesive attached, 1/2-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
   5. Fan: Forward-curved centrifugal, located at plenum air inlet.

C. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

D. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.

E. Motor:
   1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   2. Type: Electronically commutated motor.

F. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Material: 1 inch, glass fiber treated with adhesive; having 80 percent arrestance and 5 MERV.

G. Attenuator Section: 0.034-inch steel sheet.
   1. Lining: Adhesive attached, 3/4-inch- thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
   1. Location: Plenum air inlet.
I. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

J. Electric Controls: 24-V damper actuator with wall-mounted electric DDC controller and appropriate mounting hardware.

K. Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:

1. Occupied and unoccupied operating mode.
2. Remote reset of airflow or temperature set points.
3. Adjusting and monitoring with portable terminal.
4. Communication with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC."

L. Control Sequence:

1. Occupied (Primary Airflow On):
   a. Operate as throttling control for cooling.
   b. As cooling requirement decreases, control valve throttles toward minimum airflow.
   c. As heating requirement increases, fan energizes to draw in warm plenum air and hydronic heat is energized.

2. Unoccupied (Primary Airflow Off):
   a. When pressure at primary inlet is zero or less, fan is de-energized.
   b. As heating requirement increases, fan energizes to draw in warm plenum air and hydronic heat is energized.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are suitable for installation.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and airflow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 05 48.

E. Do not support from ductwork.
F. Connect to ductwork in accordance with Section 23 31 00.

3.03 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

END OF SECTION
SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Diffusers.
   B. Registers/grilles.
   C. Louvers.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.03 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. American Louver Company; ALC Grilles and Registers: www.americanlouver.com/#sle.
   B. Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
   D. Krueger-HVAC, Division of Air System Components: www.krueger-hvac.com/#sle.
   G. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com/#sle.

2.02 ROUND CEILING DIFFUSERS
   A. Manufacturers:
1. Metalaire, a brand of Metal Industries Inc: www.metalaire.com/#sle.

B. Type: Round, adjustable pattern, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sectorizing baffles where indicated. Diffuser collar shall project not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.

C. Fabrication: Steel with baked enamel finish.

D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 RECTANGULAR CEILING DIFFUSERS

A. Manufacturers:
   1. Metalaire, a brand of Metal Industries Inc: www.metalaire.com/#sle.

B. Type: Provide square, stamped, multi-core, square, adjustable pattern, stamped, multi-core, square and rectangular, multi-louvered, square and rectangular, adjustable pattern, and multi-louvered diffuser to discharge air in 360 degree, one way, two way, three way, and four way pattern with sectorizing baffles where indicated.

C. Connections: Round.

D. Frame: Provide surface mount and inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.

E. Fabrication: Steel with baked enamel finish.

2.04 CEILING SUPPLY REGISTERS/GRILLES

A. Manufacturers:
   1. Metalaire, a brand of Metal Industries Inc: www.metalaire.com/#sle.

B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.

C. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.

D. Construction: Made of aluminum extrusions with factory enamel finish.

2.05 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

A. Manufacturers:
   1. Price.

B. Type: Egg crate style face consisting of 1 by 1 by 1 inch grid core.

C. Fabrication: Grid core consists of aluminum with mill aluminum finish.

D. Frame: 1-1/4 inch margin with countersunk screw mounting.
2.06 LOUVERS

A. Manufacturers:
   1. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
   2. Greenheck.

B. Type: 4 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake.

C. Fabrication: 16 gage, 0.0598 inch thick galvanized steel welded assembly, with factory prime coat finish.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

END OF SECTION
SECTION 23 52 16 - CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured units.
B. Boiler construction.
C. Boiler trim.
D. Fuel burning system.
E. Factory installed controls.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.
B. Section 23 0913 - Instruments and Control Elements.
C. Section 23 2114 - Hydronic Specialties.
D. Section 23 5100 - Breechings, Chimneys, and Stacks.
E. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

E. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.
G. SCAQMD 1146.1 - South Coast Air Quality Management District Rule No.1146.1; current edition.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittals procedures.
B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
C. Manufacturer’s Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.
   1. Indicate compliance with specified performance and efficiency.
   2. Provide results of the following combustion tests:
      a. Boiler firing rate.
      b. Over fire draft.
      c. Gas flow rate.
      d. Heat input.
      e. Burner manifold gas pressure.
      f. Percent carbon monoxide.
      g. Percent oxides of nitrogen.
      h. Percent oxygen.
      i. Percent excess air.
      j. Flue gas temperature at outlet.
      k. Ambient temperature.
      l. Net stack temperature.
      m. Percent stack loss.
      n. Percent combustion efficiency.
      o. Heat output.

PART 2 PRODUCTS

2.01 MANUFACTURERS

   A. Natural Gas, Propane, or Combination Natural Gas/Propane for Indoor Applications:
      1. Aerco Boilers.

2.02 MANUFACTURED UNITS

   A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.
   B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

2.03 BOILER CONSTRUCTION

   A. Conform to the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.
   B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.
   C. Required Directory Listings:
2. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.

D. Heat Exchanger: Construct with materials that are impervious to corrosion where subject to contact with corrosive condensables.

E. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.

F. Insulate casing with insulation material, protected and covered by heavy-gage metal jacket.

G. Factory apply boiler base and other components, that are subject to corrosion, with durable, acrylic, powder coated, painted, weather-proofed finish.

2.04 BOILER TRIM

A. ASME rated pressure relief valve.

B. Flow switch.

C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.

D. Temperature and pressure gage.

E. Pressure Switches:
   1. High gas pressure.
   2. Low gas pressure.
   3. Air pressure.

F. Manual reset high limit.

G. Boiler Pump (where required by boiler design):
   1. Primary pump, factory supplied and sized for field installation to ensure minimum, continuous circulation through boiler.
   2. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler manufacturer's recommendations.
   3. Pump time delay.

2.05 FUEL BURNING SYSTEM

A. Provide forced draft automatic burner, integral to boiler, designed to burn natural gas, and maintain fuel-air ratios automatically.
   1. Blower Design: Statically and dynamically balanced to supply combustion air; direct connected to motor.
   2. Forced Draft Design: Mixes combustion air and gas to achieve 90 percent combustion efficiency.

B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and gas mixture.

C. Emission of Oxides of Nitrogen Requirements: Comply with SCAQMD 1146.1 for natural gas fired system, as applicable.

D. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through a sealed intake pipe
2.06 FACTORY INSTALLED CONTROLS

A. Option for internal or external (0-10) VDC control.

B. Temperature Controls:
   1. Automatic reset type to control fuel burning system firing rate to maintain temperature.
   2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding safe system water temperature.
   3. Low-fire start time delay relay.

C. Electronic PI setpoint/modulation control system.

D. Microprocessor-based, fuel/air mixing controls.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.

C. Install boiler on concrete housekeeping base, sized minimum of 4 inches larger than boiler base in accordance with Section 03 3000.

D. Coordinate factory installed controls with Section 23 0913.

E. Pipe relief valves to nearest floor drain.

F. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

G. Provide piping connection and accessories in accordance with Section 23 2114.

H. Provide for connection to electrical service in accordance with Section 26 0583.

I. Vent combustion fumes in accordance with manufacturer's recommendations. Refer to Section 23 5100.

3.02 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

END OF SECTION
SECTION 23 55 23 - GAS-FIRED RADIANT HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY
A. This Section includes gas-fired, tubular infrared and high-intensity infrared radiant heaters.

1.03 ACTION SUBMITTALS
A. Product Data: For each type of gas-fired radiant heater indicated. Include rated capacities, operating characteristics, and accessories.

1.04 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which equipment will be attached.
2. Items penetrating roof and the following:
   a. Vent and gas piping rough-ins and connections.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

1.05 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For gas-fired radiant heaters to include in emergency, operation, and maintenance manuals.
1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Burner Igniters: One hot-surface burner igniter(s) for each style of gas-fired radiant heater furnished.

1.07 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.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of gas-fired radiant heater that fails in materials or workmanship within specified warranty period.

   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 TUBULAR INFRARED HEATERS

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

   1. Calcana Industries Ltd.
   4. Reznor/Thomas & Betts Corporation.
   5. Roberts-Gordon, Inc.
   6. Schwank Inc.
   7. Solaronics, Inc.
   8. Sterling HVAC Products; Div. of Mestek Technology Inc.

B. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.20/CSA 2.34.

C. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

D. Combustion Tubing: 4-inch- diameter stainless steel with high-emissivity, high-temperature, corrosion-resistant external finish.
E. Tubing Connections: Stainless-steel couplings or flared joints with stainless-steel draw bolts.

F. Reflector: Polished aluminum, 97 percent minimum reflectivity, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Provide for rotating reflector or heater around a horizontal axis for minimum 30-degree tilt from vertical.

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
2. Include hanger kit.

G. Burner Safety Controls:

1. Gas Control Valve: Single-stage, regulated redundant 24-V ac gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
2. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.
3. Control Panel Interlock: Stops burner if panel is open.

H. Burner and Emitter Type: Gravity-vented power burner, with the following features:

1. Emitter Tube: 4-inch-diameter, aluminized-steel tubing with sight glass for burner and pilot flame observation.
2. Venting: Connector at exit end of emitter tubing for vent-pipe connection.
4. Combustion-Air Connection: Duct connection for combustion air to be drawn directly from outdoors by burner fan.

2.02 HIGH-INTENSITY INFRARED HEATERS

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

3. Panelbloc, Inc.
4. Reznor/Thomas & Betts Corporation.
5. Roberts-Gordon, Inc.
6. Schwank Inc.
7. Solarronics, Inc.
8. Sterling HVAC Products; Div. of Mestek Technology Inc.
B. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.19A/CSA 2.35A, "Gas-Fired, High-Intensity Infrared Heaters."

C. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

D. Burner: Aluminized-steel plenum chamber with stainless-steel retainers and direct spark ignition.

E. Emitter: Ceramic combustion surface.

F. Reflector: Polished aluminum.

G. Accessories:
   1. Parabolic reflector.
   2. Wire grid for increased efficiency.
   3. Protective screen.
   5. Stainless-steel flexible connector with manual valve.
   7. Preassembled chain suspension kit.

2.03 CONTROLS

A. Thermostat: Devices and wiring are specified in Division 23 Section "Instrumentation and Control for HVAC."

B. Thermostat: Single-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install and connect gas-fired radiant heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments.
   1. Spring hangers are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Maintain manufacturers’ recommended clearances to combustibles.
3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to gas-fired radiant heaters to allow service and maintenance.

C. Gas Piping: Comply with Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Division 23 Section "Breechings, Chimneys, and Stacks."

E. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
   1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   2. Verify bearing lubrication.
   3. Verify proper motor rotation.
   4. Test Reports: Prepare a written report to record the following:
      a. Test procedures used.
      b. Test results that comply with requirements.
      c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

3.04 ADJUSTING

A. Adjust initial temperature set points.
B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired radiant heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 23 55 33 - FUEL-FIRED UNIT HEATERS

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Gas fired unit heaters.

1.02  RELATED REQUIREMENTS
A. Section 23 51 00 - Breechings, Chimneys, and Stacks.

1.03  REFERENCE STANDARDS
A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

1.05  QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2  PRODUCTS

2.01  GAS FIRED UNIT HEATERS
A. Manufacturers:

B. Unit Heaters: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
   2. Discharge Louvers: Individually adjustable horizontal and vertical louvers to match cabinet finish.

C. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner.

D. Supply Fan: Propeller type with direct drive, variable pitch motor pulley.

E. Heat Exchanger: Aluminized steel welded construction.

F. Gas Burner:
   1. Atmospheric type with adjustable combustion air supply,
   2. Gas valve, two stage provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
   3. Electronic pilot ignition, with electric spark igniter.

G. Gas Burner Safety Controls:
   1. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
   2. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.

H. Operating Controls
   1. Room Thermostat: Cycles burner to maintain room temperature setting.

I. Performance:
   1. Ratings: Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than requirements of ASHRAE Std 90.1 I-P; seasonal efficiency to ASHRAE Std 103.

2.02 ROOM THERMOSTATS

A. Manufacturers:

B. Room Thermostat: Adjustable, low voltage, to control burner operation, compressor and condenser fan and supply fan to maintain temperature setting. Include system selector switch (heat-off-cool) and fan control switch (auto-on).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that space is ready for installation of units and openings are as indicated on shop drawings.
B. Verify that proper power supply is available.

C. Verify that proper fuel supply is available for connection.

### 3.02 INSTALLATION

A. Install in accordance with NFPA 90A.

B. Install gas fired units in accordance with NFPA 54 and applicable codes.

C. Provide vent connections in accordance with NFPA 211. Refer to Section 23 51 00.

END OF SECTION
SECTION 23 62 13 - PACKAGED AIR-COOLED CONDENSING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Condensing unit package.
B. Charge of refrigerant and oil.
C. Controls and control connections.
D. Refrigerant piping connections.
E. Motor starters.
F. Electrical power connections.

1.02 SUBMITTALS

A. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams. Include equipment served by condensing units in submittal, or submit at same time, to ensure capacities are complementary.
B. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.
C. Design Data: Indicate pipe and equipment sizing.
D. Manufacturer's Instructions: Submit manufacturer’s complete installation instructions.
E. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.
F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.04 WARRANTY

A. Provide a five year warranty to include coverage for refrigerant compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carrier
B. Trane
2.02 MANUFACTURED UNITS

A. Construction and Ratings: In accordance with AHRI 210/240. Test in accordance with ASHRAE Std 23.1.
B. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1 I-P.
C. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.03 CASING

A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.
B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.
C. Provide removable access doors or panels with quick fasteners and piano hinges.

2.04 CONDENSER COILS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig, and vacuum dehydrate. Seal with holding charge of nitrogen.
B. Coil Guard: Expanded metal with lint screens.

2.05 FANS AND MOTORS

A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Equip with roller or ball bearings with grease fittings extended to outside of casing.
B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in current and thermal overload protection. Refer to Section 23 0513.

2.06 COMPRESSORS

A. Compressor: Hermetic scroll type.
B. Mounting: Statically and dynamically balance rotating parts and mount on rubber-in-shear vibration isolators.
C. Lubrication System: Reversible, positive displacement oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.
D. Motor: Constant speed 1800 rpm suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting. Furnish with starter.
E. Capacity Reduction Equipment: Hot gas bypass.
F. Sump Oil Heater: Evaporates refrigerant returning to sump during shut down. Energize heater continuously when compressor is not operating.

2.07 CONTROLS

A. On unit, mount weatherproof steel control panel, NEMA 250, containing power and control wiring, molded case disconnect switch, factory wired with single point power connection.
   1. Factory mount disconnect switch on unit under provisions of Section 26 0583.
B. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for controls power. Provide manual reset current overload protection. For each condenser fan, provide across-the-line starter with starter relay.
C. Provide safety controls arranged so any one will shut down machine:
   1. High discharge pressure switch (manual reset) for each compressor.
   2. Low suction pressure switch (automatic reset) for each compressor.
   3. Oil Pressure switch (manual reset).
D. Provide the following operating controls:
   1. Refer to Section 23 0993.
   2. Thermostat located in room cycles compressors activates solenoid valves in refrigerant circuit.
   3. One minute off timer prevents compressor from short cycling.
   4. Periodic pump-out timer to pump down on high evaporator refrigerant pressure.
   5. Low ambient temperature controls.
   6. Hot gas bypass sized for minimum compressor loading on one compressor only, bypasses hot refrigerant gas to evaporator.
   7. Lead-lag switch to alternate compressor operation.
   8. Low ambient thermostat to lock out compressor at low ambient temperatures.
E. Provide controls to permit operation down to 0 degrees F ambient temperature.
   1. Thermostat to cycle fan motors in response to outdoor ambient temperature.
   2. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
   3. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.
F. Gages: Prepiped for suction and discharge refrigerant pressures and oil pressure for each compressor.
PART 3  EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's installation instructions.
   B. Complete structural, mechanical, and electrical connections in accordance with
      manufacturer's installation instructions.
   C. Provide 8" minimum base, coordinate with general contractor.

3.02 SYSTEM STARTUP
   A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace
      losses of oil or refrigerant prior to end of correction period.
   B. Charge system with refrigerant and test entire system for leaks after completion of
      installation. Repair leaks, put system into operation, and test equipment performance.
   C. Shut-down system if initial start-up and testing takes place in winter and machines are
      to remain inoperative. Repeat start-up and testing operation at beginning of first
      cooling season.
   D. Provide cooling season start-up, and winter season shut-down for first year of
      operation.

END OF SECTION
SECTION 23 73 13 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
   a. Certified fan-performance curves with system operating conditions indicated.
   b. Certified fan-sound power ratings.
   c. Fan construction and accessories.
   d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.
1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each air-handling unit.
2. Fan Belts: One set for each air-handling unit fan.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. AHRI Certification:

1. Air handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.
3. Water Coils shall be factory tested according to AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," and shall be listed and labeled by AHRI.
4. Energy wheels shall be factory tested according to AHRI 1060, “Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment” and shall be listed and labeled by AHRI.

D. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Comply with NFPA 70.

1.07 COORDINATION

A. Coordinate sizes and locations of concrete bases and structural-steel supports with actual equipment provided.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; a member of the United Technologies Corporation Family.
   2. Diakin
   3. Trane; American Standard Inc.
   4. Johnson Controls, YORK.

2.02 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

D. Steam Coils: Factory tested to 300 psig and to 200 psig under water according to ARI 410 and ASHRAE 33.

E. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.

2.03 UNIT CASINGS

A. General Fabrication Requirements for Casings:
   1. Construct unit with frame and panels.
   2. Panels: Double wall.
   4. Deflection: Less than 1:200 at 1.5 time design static pressure up to plus or minus 8 in wg.
   5. Leakage: 1 percent at plus or minus 8 in wg, or 50 cfm, whichever is greater.
   7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1. Coil sections shall be double wall.

B. Inspection and Access Panels and Access Doors:
1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.

2. Inspection and Access Panels:
   a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:
   a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Surface mount adjustable door handles.
   d. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

4. Locations and Applications:
   a. Hinged double-wall access door on either side with removable access panel(s) on the other side:
      1) Fan section.
      2) Coil section.
      3) Damper section.
      4) Filter section.
      5) Mixing section.
      6) Humidifier section.
   b. Access Section: Removable inspection and access panels.
   c. Diffuser Section: Removable inspection and access panels.

5. Service Light: 100-W vaporproof fixture with switched junction box located outside adjacent to door.
   a. Locations: Fan section.

C. Condensate Drain Pans:

1. Fabricated with minimum one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   b. Depth: A minimum of 2 inches deep.
2. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.

3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on end of pan.

4. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.04 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
      1) Fabric Minimum Weight: 26 oz./sq. yd..
      2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      3) Fabric Service Temperature: Minus 40 to plus 200 deg F.

C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

D. Backward-Inclined, Centrifugal Fan Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to
flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

F. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

G. Axial Fans: Fan wheel and housing, straightening-vane section, factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.

H. Flow Meter:
   1. System shall report airflow with plus or minus 5 percent total accuracy. Airflow may be measured directly or differential pressure may be measured. Submitted fan performance and sound levels shall include affect of flow meter.

I. Fan Shaft Bearings:
   1. Rated L-50 life of 200,000 hours according to ABMA.
   2. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.

J. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
   1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   2. Motor Pulleys: Adjustable pitch for use with 5 hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
   3. Belts: Oil resistant, non-sparking, and non-static; in matched sets for multiple-belt drives.

K. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 2 inches.

L. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section "Common Motor Requirements for HVAC Equipment."
   1. Enclosure Type: Open drip-proof or totally enclosed, fan cooled.
   2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

M. Variable Frequency Controllers:
1. Description: NEMA ICS 7.0; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

2. Output Rating: 3-phase; 6 to 66 Hz, with torque constant as speed changes.

3. Unit Operating Requirements:
   a. Minimum Efficiency: 97 percent at 60 Hz, full load.
   b. Starting Torque: 100 percent of rated torque or as indicated.
   c. Speed Regulation: Plus or minus 1 percent.

4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

5. Internal Adjustability Capabilities:
   a. Minimum Speed: 5 to 25 percent of maximum rpm.
   b. Maximum Speed: 110 percent of maximum rpm.

6. Self-Protection and Reliability Features:
   a. Input transient protection by means of surge suppressors.
   b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
   c. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
   d. Instantaneous line-to-line and line-to-ground overcurrent trips.
   e. Loss-of-phase protection.
   f. Reverse-phase protection.
   g. Short-circuit protection.

7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto-speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

8. Include a fireman’s override input. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run at a preset speed or in a separate PID mode.

9. Provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus.

10. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet MS/TP. The use of third-party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority (i.e. BTL Listing for BACnet).
11. Meters or digital readout devices and selector switch, mounted flush in controller door or remotely mounted and connected to indicate the following controller parameters:
   a. Output frequency (Hertz).
   b. Motor speed (rpm).
   c. Motor status (running, stop, fault).
   d. Motor current (amperes).
   e. Motor torque (percent).
   f. Fault or alarming status (code).
   g. Proportional-integral-derivative (PID) feedback signal (percent).
   h. DC-link voltage (volts direct current).
   i. Set-point frequency (Hertz).
   j. Motor output voltage (volts).

12. Control Signal Interface:
   a. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
   b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
      1) 0 to 10-V dc.
      2) 0-20 or 4-20 mA.
      3) Potentiometer using up/down digital inputs.
      4) Fixed frequencies using digital inputs.
      5) RS485.
      6) Keypad display for local hand operation.
   c. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hertz).
      2) Output current (load).
      3) DC-link voltage (volts direct current).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hertz).

13. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.


2.05 COIL SECTION

A. General Requirements for Coil Section:
   Stantec Architecture Inc.
   MODULAR INDOOR CENTRAL STATION AIR-HANDLING UNITS
   Adams County Fleet & Public Works
   23 73 13 - 8
   4166-01
1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

B. Water Coil:

1. Coil Type: Self-draining [and Cleanable].
2. Tube Material: Copper.
3. Tube Thickness: 0.02 inch.
4. Fin Type: Plate.
5. Fin Material: Aluminum.
6. Headers:
   a. Cast iron with cleaning plugs and drain and air vent tappings.
   b. Seamless copper tube with brazed joints, prime coated.
7. Coil Working-Pressure Ratings: 200 psig, 325 deg F.
8. Frames: Channel frame, galvanized or stainless steel.

2.06 AIR FILTRATION SECTION:

A. Refer to Section “Particulate Air Filtration”, for filter requirements.

B. Filters including one complete set for temporary use at site shall be provided independent of the AHU. AHU manufacturer shall install filter housings and racks in filter section compatible with filters specified. Furnish 2 inch thick, temporary filters.

C. Provide factory fabricated filter section of the same construction and finish as the AHU casing including filter racks and hinged double wall access doors.

2.07 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Filter Gage:

1. 3-1/2-inch diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 3 percent of full-scale accuracy.
6. Range: to suit filter type.
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.08 MIXING BOX/ECONOMIZER

A. Mixing box shall consist of casing and outdoor air and return air dampers in opposed blade arrangement with damper linkage for automatic operation. Dampers shall be of low leak design with metal compressible bronze jamb seals and extruded vinyl edge seals on all blades. Blades shall rotate on stainless steel sleeve bearings or bronze bushings. Maximum damper length shall be 60 inches. Damper operators shall be furnished and mounted in an accessible and easily serviceable manner.

2.09 FILTER/MIXING BOX:

A. Combination Filter/Mixing box shall comply with Mixing Box/Economizer and Filter paragraphs above.

2.10 DAMPERS

A. General Requirements for Dampers: Leakage rate, tested according to AMCA 500-D, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 4 CFM per square foot at 1.0 in wg pressure differential.

B. Airflow Measurement Dampers: Tested in accordance with AMCA Standard 611 and bearing the AMCA Ratings Seal for Airflow Measurement Performance in the outdoor and/or return air opening. Capable of measuring from 7.5 to 100 percent of unit airflow at an accuracy of plus or minus 5 percent. Temperature compensated output signal of 2 to 10 Vdc.

C. Electronic Damper Operators:
   1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
   4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   5. Fail-Safe Operation: Mechanical, spring-return mechanism.
   6. Power Requirements: Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
   7. Proportional Signal: 2 to 10 V dc or 4 to 20 mA.
   8. Run Time: 12 seconds open, 5 seconds closed.

D. Face-and-Bypass Dampers: Opposed-blade, galvanized-steel dampers with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame and with operating rods connected with a common linkage.
Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.

E. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed blade arrangement with steel operating rods rotating in stainless-steel sleeve bearings mounted in a frame, and with operating rods connected with a common linkage. Outdoor and relief air damper linked to be normally closed.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.02 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete"

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.03 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Steam and Condensate Piping: Comply with applicable requirements in Section "Steam and Condensate Heating Piping." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

G. Refrigerant Piping: Comply with applicable requirements in Section "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.06 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Comply with requirements in Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.07 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION
SECTION 23 81 27 - SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
1. Heating: None.
2. Cooling: Outdoor electric condensing unit with evaporator coils in multiple ductless indoor units ("mini-split").
3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
B. Performance Requirements: See Drawings for additional requirements.

2.02 INDOOR UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
1. Location: High-wall.
3. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.

B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
   1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.

C. Remote Actuators:

2.03 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
   1. Refrigerant: R-410A.
   2. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
   3. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.

B. Compressor: Hermetic, two speed 1800 and 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.

C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

D. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).
   1. Provide thermostatic expansion valves.

E. Operating Controls:
   1. Control by room thermostat to maintain room temperature setting.
   2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to 0 degrees F.

2.04 ACCESSORY EQUIPMENT

A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
   1. Automatic switching from heating to cooling.
   2. Preferential rate control to minimize overshoot and deviation from setpoint.
   3. Thermostat Display:
      a. Actual room temperature.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
B. Install in accordance with NFPA 90A and NFPA 90B.
C. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. The General Conditions of the Contract, Supplementary Conditions of the General Contract, and requirements of Division 01 Specification sections, apply to work under this Division and all following sections of Division 26, 27, 28.

B. Provide labor, materials, temporary facilities, equipment and services to install electrical systems as indicated or required, which includes but is not limited to, masonry, excavation and backfill, concrete, carpentry, painting, conduit sleeves and supports, anchors, vibration and sound isolation, access doors, cutting and patching, and similar work.

C. Provide temporary electricity for electrical work and the work of other trades. Include engineered plans required for permit by authority having jurisdiction for temporary electrical services. Coordinate with General Contractor for power requirement of General contractor and their sub-contractors.

D. Provide commissioning of Electrical Systems per IECC.

E. Provide commissioning of Lighting and Lighting Controls per IECC.

1.02 SECTION INCLUDES

A. Basic electrical requirements for the installation of the electrical systems in Division 26 specifications that apply.

B. Basic electrical requirements for for integration and coordination of Communications systems in Division 27, and Fire Alarm and Detection systems in Division 28.

C. Basic electrical requirements for for integration and coordination of Plumbing systems in Division 22, and HVAC systems in Division 23.

D. Basic requirements as it relates to Intent and interpretations, Abbreviations and Acronyms, Definitions, Regulatory Requirements, Reference Standards, Administrative Requirements, Job Conditions, Permits and Fees, Submittals, Quality Assurance, Delivery, Storage and Handling, Field Conditions, Warranty.

E. Basic requirements as it relates to Product Standards, Substitutions, Owner-Furnished Products, Workmanship, Supervision, Equipment Modification, Existing Equipment, Preparation.

F. Basic requirements as it relates to Execution of Workmanship, Supervision, Equipment Modification, Existing Equipment, Preparation, Installation, Repair, Field Quality Control, System Start-Up, Adjusting, Cleaning, Closeout Activities, Protection, Maintenance.
1.03 INTENT AND INTERPRETATIONS

A. It is the intent of these Drawings and Specifications to result in a complete electrical installation in complete accordance with applicable codes and ordinances.

B. Neither the professional activities of the Engineer nor the presence of the Engineer or its employees and subconsultants at a construction/project site shall relieve the Contractor of its obligations, duties, and responsibilities including, but not limited to, construction means, methods, sequence, techniques, or procedures necessary for performing, superintending, and coordinating the Work in accordance with the Contract Documents.

C. Drawings are diagrammatic in character and do not necessarily indicate every required junction box, pull box, ell, etc. Items not specifically mentioned in the specification or noted on the Drawings, but which are obviously necessary to make a complete working installation, shall be included.

D. Drawings and Specifications are complementary. Whatever is called for in either is binding as though called for in both. The more stringent requirements shall govern.

E. Drawings shall not be scaled for rough in measurements or used as submittals. Where drawings are required for these purposes or have to be made from field measurements, take the necessary measurements and prepare the drawings.

F. Symbols used on the Drawings are defined in the Electrical Legend on the Drawings. Symbols indicated on the Legend may not necessarily be required for the Project.

G. If conflicts are discovered in Contract Documents as work progresses, a set of prints marked with red pencil showing recommended modifications shall be submitted to the Architect/Engineer for approval prior to installation.

H. The Drawings indicate the general arrangement of circuits and outlets, locations of switches, panelboards and other work. However, rearrangement and re-circuiting shall not be permitted without specific acceptance.

I. Incidental equipment such as tools, scaffolding, consumable items, testing equipment, appliances and the like shall be provided whether listed or not. Labor, fees, licenses, start up and checkout services shall also be provided.

J. In the event that discrepancies exist or required items or details have been omitted, notify the Architect in writing of such discrepancy or omission at least five days prior to bid date. Failure to do so shall be construed as willingness to supply necessary materials and labor required for the proper completion of this work. For discrepancies which are not reported by Contractor the most stringent requirement shall apply.

K. In the event that additional information is required during construction, request such information from the Architect in writing prior to performing related work. The request for information shall include an explanation of the information required including references to related portions of the Documents and Contractor’s recommendations.

L. Allowances for Contingencies: No change in contract price will be allowed for alternate work which requires approximately the same work to adjust or relocate electrical
components or devices as part of the construction coordination work. An adequate allowance shall be included in the bid price for such coordination contingencies and for the additional work required by these coordination adjustments.

1.04 ABBREVIATIONS AND ACRONYMS

A. These specifications include conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
   1. Abbreviated Language: Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpreted as the sense requires. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.
   2. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where abbreviations and acronyms are used, they mean the recognized name of the trade association, standards-generating organization, authorities having jurisdiction, or other entity applicable to the context of the text provision.

B. Abbreviations shown on the drawing legend shall also apply.

C. CxA: Shall mean Commissioning Agent.

1.05 DEFINITIONS

A. The terms "the Contractor" or "this Contractor" when used in this Division of specifications, shall be construed to mean Contractor for electrical work.

B. Instructions such as "provide the outlets..." shall mean the same as though the words "This Contractor shall" preceded each instruction. "Provide" shall mean "furnish and install."

C. Where the words "accepted" or "acceptable" are used, such "accepted" or "acceptable" action by the Architect/Engineer denotes that the work or equipment item is in conformance with the design concept of the Project and, in general, complies with the pertinent information given in the Contract Documents.

1.06 REGULATORY REQUIREMENTS

A. Errors and omissions in the Contract Documents do not relieve the Contractor from providing the work in accordance with regulatory requirements.

B. Execute and inspect work in accordance with Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed.

C. Conform to all OSHA workplace requirements.

D. Follow requirements of Reference Standards listed in paragraph 1.07 below and listed in other specification sections included in contract document.
E. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

F. Conform to guidelines and requirements of local utility companies.

1.07 REFERENCE STANDARDS


D. ICC (IFC) - International Fire Code; 2015

E. ICC (IMC) - International Mechanical Code; 2015.

F. ICC (IPC) - International Plumbing Code; 2015.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Utility Coordination: Coordinate the installation of equipment with size, location and installation of service utilities.
   1. Submit all required documentation for new services with local utilities.
   2. Coordinate with Owner and utility companies outages due to interfacing electrical equipment. Outages must be scheduled at least five days in advance and shall be at a time and duration acceptable to the Owner. Outages at a time other than normal working hours, shall not entitle the Contractor to additional overtime or compensation beyond that in the bid.

B. Coordination:
   1. Locations of devices, outlets, etc., as shown on the Drawings are approximate unless dimensioned or otherwise noted. Where locations of devices, outlets, etc., are dimensioned or noted on the Drawings, verify location with Architect's representative or with equipment to be supplied. Exact locations of devices, outlets, etc., shall be coordinated with field conditions. Ensure that switches or other electrical devices are mounted such that they are not "trapped" behind opened doors or otherwise rendered inaccessible, regardless of locations indicated on Drawings.

C. Prior to ordering equipment, determine that equipment shall adequately pass through building openings and passage ways providing unobstructed access to final equipment location. Equipment shall be manufactured and shipped in sections for assembly in
final equipment location when inadequate building openings and passage ways limit access. Submittals shall indicate sectionalized manufacture of equipment.

D. Before ordering equipment and before work is installed, determine that equipment shall properly fit the space; that required clearances can be maintained and that electrical equipment can be located without interferences between systems, with structural elements or with the work of other trades.

E. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

F. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

G. Scheduling: Schedule work to coordinate with that of other trades to minimize delays. 1. Coordinate materials and product lead times and delivery dates to ensure no delays to construction schedule.

1.09  JOB CONDITIONS

A. Examine the premises and become familiar with existing conditions prior to bidding. No allowance shall subsequently be made for not following this procedure.

B. Protect work, materials, and equipment against theft, injury, or damage until it has been installed, tested, and accepted.

C. Be responsible for damage to the property of the Owner or to the work of other trades due to the electrical work during the construction and warranty period.

D. Ascertain the scope of other trades’ responsibilities and determine if the installation of proposed equipment shall affect the operation or code compliance of equipment. Relocate, modify or otherwise revise equipment as required to maintain operational integrity and code compliance.

E. Be responsible for the safety of the workers and others on the construction site.

1.10  PERMITS AND FEES

A. Obtain all permits required for the electrical work on this Project.

B. Pay fees, including service installation and connection charges, aid to construction fees, and permit fees.

C. Coordinate with Owner and General Contractor any fees that will be paid by Owner.

D. No work shall be started prior to obtaining necessary permits and payment of required fees. Work installed prior to obtaining proper permits shall, if required by permitting authority, be redone in compliance with requirements.

E. Notations made on permit or review documents shall be observed. Additional requirements noted by jurisdictional authority shall be made part of the requirements for construction of the Project. Additional costs for implementing jurisdictional
authority's requirements, if any, shall be submitted to the Architect prior to construction for review.

1.11 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures in addition to requirements or this section.

B. Submit resume of qualifications and experience of the superintendent for review by the Architect. Superintendent shall have as a minimum five years of continuous experience on projects of similar size. Resume shall include a listing of experience, projects, and references. Superintendent for this Project may not be changed without approval.

C. The purpose of Submittals is to ensure that Contractor understands design requirements and demonstrates understanding by indicating and detailing intended materials, methods, and proper installation practices. If discrepancies between Submittals and Contract Documents are discovered either prior to or after Submittals are reviewed, requirements of Contract Documents shall take precedence. Submittals which are submitted, but which are not required by Contract Documents, shall be returned Not Reviewed.

D. Review of Submittals and action recommended as result of review is a courtesy extended to Contractor by Engineer. This review is intended to minimize delivery to job site and installation of materials and equipment that do not meet intent of Construction Documents. Submission of material for review does not alter Contractor's obligation to follow intent of Construction Documents, nor Contractor's responsibility to comply therewith regardless of action noted in Engineer's review.

E. Submit a schedule indicating items to be submitted with respective dates prior to submittals. Submittals shall be submitted to allow the Engineer's possession of such for a minimum of two weeks. Take this into account for long lead time items.

F. Product Data: Submittals shall include catalog cut-sheets, manufacturer's data sheets, written descriptions, specification sheets detailing the associated product, item, assembly and installation. Highlight characteristics and features within product data submittals with a yellow highlighting marker to identify compliance with the Drawings and Specifications. Indicate characteristics and features which are missing or vary from the Drawings and Specifications.

G. Refer to individual specification sections included in construction documents for additional specific submittal requirements for product data, shop drawings, samples, test reports, materials or equipment in those sections.

H. Submittals include details, installation drawings, assembly drawings, fabrication drawings, diagrams, etc., which show adaptation or installation of Contractor-furnished products or materials for overall Project. Electronic files, required for preparation of Submittals, shall be compatible with software and software version as decided by Architect or Engineer at time of Submittal production. Electronic files if required for preparation of Submittal may be obtained from Architect or Engineer, at which time an indemnification form releasing the Architect and Engineer from liability for the
Contractor’s record drawing changes on such files shall be executed. Include the following:

1. **Legend:** Match Contract Documents.
2. **Format:** Sheet size to match Contract Documents with title block indicating Project name, manufacturer's name and logo, date of submittal, content of sheet, and sheet number.
3. **Wiring and Control Diagrams:** System and equipment wiring diagrams and control diagrams include multiple floor and building separation lines, sizes of conduits, size and number of conductors in each conduit, wiring color code, and identification of terminals and interconnections. Differentiate clearly between factory and field installed wiring. Make diagrams specific to this Project.
4. **Floor Plans:** Plan titles, scales, north arrows, column lines, and room names and numbers shall match Contract Documents.

I. Submit samples of equipment as indicated or requested.

J. Prior to ordering equipment or beginning installation work, assemble, prepare, and submit shop drawings required for Project. Submit Submittals as required by individual Sections of Specifications. As a minimum, provide product data submittals for equipment indicated on the Drawings whether mentioned in these Specifications or not.

K. Contractor shall thoroughly check Subcontractors' or vendors’ Submittals and, after approving Submittals, provide Submittals for review. Partial or incomplete submittals will not be reviewed and will be returned Not Reviewed. Submittals that do not bear Contractor’s review stamp shall be returned Not Reviewed.

L. Submittals submitted or re-submitted shall bear a unique Contractor’s submittal number. Submittals shall be submitted in Electronic PDF format. PDFs shall be original product catalog pages in PDF format and not scanned image files from a copier or scanner. Engineer shall retain a copy for our records. After review, Submittals shall be returned together with Submittal Review Sheet which indicates comments on Submittals with specific actions such as: No Exception Taken; Make Corrections Noted, Re submittal Not Required; Make Corrections Noted, Re-submittal Required; Rejected; Not Reviewed. Continue to re-submit Submittals until No Exception Taken or Make Corrections Noted, Re submittal Not Required action is indicated. Provide a copy of the original submittal review comments for re-submitted items.

M. The Contractor shall be responsible for extra fees incurred by the Engineer resulting from subsequent review(s) of submittals which fail to meet the requirements herein. Such extra fees shall be deducted from payment to the Contractor.

N. **Product Data:** Provide as required by other individual sections of the specifications.

O. **Shop Drawings:** Provide as required by other individual sections of the specifications.

P. **Samples:** Provide samples as required by other individual sections of the specifications.

Q. **Certificate:** Certify that products of this section meet or exceed specified requirements.
R. Delegated Design Data: Provide as required by other individual sections of the specifications.

S. Test Reports: Provide as required by other individual sections of the specifications.

T. Evaluation Service Reports: Show compliance with specified requirements.

U. Manufacturer's Instructions: Provide as required by other individual sections of the specifications.

V. Source Quality Control Submittals: Provide as required by other individual sections of the specifications.

W. Field Quality Control Submittals: Provide as required by other individual sections of the specifications.

X. Manufacturer Reports: Indicate as required by other individual sections of the specifications.

Y. Erection Drawings: Indicate as required by other individual sections of the specifications.

Z. Sustainable Design Documentation: Provide as required by other individual sections of the specifications and by commissioning agent.

AA. Special Procedures Submittals: Indicate as required by other individual sections of the specifications.

AB. Designer's Qualification Statement. Provide as required by other individual sections of the specifications.

AC. Manufacturer's Qualification Statement. Provide as required by other individual sections of the specifications.

AD. Maintenance Contracts. Provide as required by other individual sections of the specifications.

AE. Operation & Maintenance Data: Provide as required by other individual sections of the specifications.

1. Make up the operating and maintenance manuals as specified and submit no later than [2] weeks prior to the completion of the Project.

2. Information contained in the operating and maintenance manuals consist of submittal materials reflecting equipment as supplied and installed, test reports, warranties, description of required testing and testing methods, description of routine maintenance, cleaning, adjustments, and service required, suggested frequency of testing and maintenance, and recommended replacement parts with a list of names, addresses, and telephone numbers of service organizations that carry stock of such replacement parts.

3. Manuals shall be 8-1/2 inch x 11 inch size. Catalog pages and data in manuals shall be neat, clean prints. Larger drawings shall be accordion folded to above size. An index shall be provided which shall list contents in an orderly manner. Each copy of the operating and maintenance manual shall be bound in hard back or loose-leaf binder with hard cover, shall be adequately labeled for
identification, and shall include plastic tabs coordinated with Index. Provide a separate tabbed section, with a list of testing required to maintain warranty for products and systems provided as part of this project.

4. Provide two copies of operation and maintenance manuals unless otherwise specified in Division 1 Closeout requirements.
   a. Submit one copy of the manual to the Architect for review prior to preparation of final copies. After review, make changes as noted and prepare 2 final copies of manual to be turned over to the Owner.
   b. This contract shall not be considered completed nor shall final payment be made until specified material, including test reports and warranties are received in this operating and maintenance manual and the manual is approved by the Architect.

AF. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

AG. Project Record Documents as follows:
   1. Keep in custody during entire period of construction, a current set of documents indicating changes that have been made to the Contract Documents. Changes to be noted on the documents shall include but shall not be limited to, panelboard, luminaire, equipment, and other schedules; circuiting; equipment, luminaires, or conduit located more that 2 feet from where shown on Drawings; electrical equipment ratings; modifications to Specifications. Incorporate Addenda, accepted Alternates, Change Orders, and other Document revisions which occurred after the award of the General Contract or the start of construction activities into the Record Documents. Notations and changes shall be done in a neat and legible manner in accordance with Architect's and Engineer's instructions. Changes shall be noted in red, deletions in green, and notes in blue.
   2. At the completion of the Project, mark equipment designations on the documents. Designations shall match the engraving on the tags installed as called for elsewhere in these specifications.
   3. Upon completion of work, develop and submit a complete set of electronic Record Documents (Drawings and Specifications), which incorporate changes documented during construction. The Contract Documents set the standard for content and methods of presentation for the Record Documents. The Record Drawings title blocks shall clearly indicate the Drawings as Record Documents, Contractor’s corporate name and logo (if applicable), and the Record Document submittal date. Electronic files shall be compatible with software and software version as decided by Architect or Engineer at time of Record Drawing production. Electronic files for preparation of Record Documents may be obtained from Architect or Engineer, at which time an indemnification form releasing the Architect and Engineer from liability for the Contractor’s record drawing changes on such files shall be executed.
   4. The Contract shall not be considered completed until these Record Documents have been reviewed and accepted by the Architect.

AH. Sustainable Design Closeout Documentation: as required by other individual sections of the specifications and by commissioning agent.
AI. Software: Copy of software provided under this section or any other individual sections of the specifications.

AJ. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Furnish extra materials, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to the Owner

1.12 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

C. The manufacturer's material or equipment listed first in the Specifications or on the Drawings are types to be provided for establishment of size, capacity, grade and quality.

D. Additional manufacturer's materials or equipment listed are considered to be "other acceptable" manufacturers and the cost of changes in construction required by their use shall be borne by this Contractor.

E. Review of Submittals for equipment supplied is mandatory as a condition of acceptance of work. Installation of equipment prior to review shall be at Contractor's risk.

F. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

G. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver: Make provisions for receiving and storing materials, including Owner furnished materials to be installed under this Division. Carefully mark and store materials. Carefully check and inspect materials furnished for installation, and furnish a receipt acknowledging acceptance of delivery and condition of the materials received. Do not use received materials which contain cracks, dents, abrasions, or other defects. Mark such materials rejected and remove from site or return to supplier for replacement.

B. Store materials and equipment under cover and elevated above grade.

C. Protect materials and equipment from physical damage, construction dirt, and the elements from the time they are delivered until final acceptance. The Contractor installing the equipment or materials shall be responsible for their protection.
1.14 FIELD CONDITIONS

A. Ambient Conditions: Do not install materials or equipment when temperatures are above or below manufacturer recommended ambient conditions.

B. Ambient Conditions: Maintain ambient temperatures at facility during and after installation of materials and equipment.

1.15 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide 1 year manufacturer warranty for materials, workmanship and the successful operation of equipment installed from the date of acceptance of the entire work. Guarantee to repair or replace at Contractor's expense, work which may show defect during that time, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

PART 2 PRODUCTS

2.01 PRODUCT STANDARDS

A. Unless otherwise specified, materials and equipment shall be of domestic (USA) manufacture.

B. Unless otherwise specified, materials and equipment shall be the manufacturer's current model and bear manufacturer's name and model number.

C. All electrical equipment shall be listed and labeled with the Underwriters Laboratory tag or other listing as approved by the local jurisdictional authority. Custom designed items shall be fabricated of UL approved materials and UL listed as a complete assembly as required.

D. Throughout Specifications, various materials, equipment, apparatus, etc., are specified by manufacturer, brand name, type or catalog number. Such designations are to establish standards of desired quality and construction and shall be the basis of the bid. Substitutions shall be allowed only as specified herein.

2.02 SUBSTITUTIONS

A. Material and equipment used in bids shall be as specified. Proposed substitutions shall be reviewed after award of contract during submittal review. Proposed substitutes shall be clearly labeled as a substitute. Submittals shall include data necessary for complete evaluation of the proposed substitution. Substitution materials and equipment used in bids shall be at Contractor's risk, and as such are subject to rejection during submittal review. The Contractor shall be responsible for fees for
re-design incurred by the Engineer resulting from the use of substitution materials. Such extra fees shall be deducted from payment to the Contractor.

B. Where "other acceptable" manufacturers are named, their products may be used provided they totally meet the Specifications and are dimensionally suitable and operationally identical to the specified item. The decision as to whether or not such items are equal to the specified items shall be made by the Architect during submittal review.

2.03 OWNER-FURNISHED PRODUCTS
A. Wiring for Equipment Furnished by Others: Provide electrical services to equipment furnished by others. Provide final connections unless otherwise noted. Where final connections are to be made by others, install outlet box and pull in conductors leaving 8 inch pigtails for each conductor. Conductors shall be taped and appropriate cover plate installed over box. Control and alarm wiring for such equipment shall be provided by the equipment supplier or trade providing equipment unless otherwise noted.

PART 3 EXECUTION

3.01 WORKMANSHIP
A. Workmanship shall be first quality throughout and shall be in complete accordance with the applicable codes. The appearance of the work shall be of equal importance to its operation. Lack of quality workmanship shall be considered sufficient reason for rejection of a system in part or in whole.

3.02 SUPERVISION
A. Supervise work so it shall proceed in proper sequence without delay to other trades. The superintendent shall be on the Project site for the duration of the Project to ensure that Contract Documents are being followed. A ratio of not less than 1:1 shall be maintained between journeymen and apprentices.

B. Superintendent shall have as a minimum five years of continuous experience on projects of similar size. Superintendent for this Project may not be changed without approval.

C. The Architect may have an observer on the site whose interpretations of the Contract Documents shall be followed.

3.03 EQUIPMENT MODIFICATION
A. Where existing equipment is to be modified, furnish materials and labor necessary to modify or add to the equipment. Modifications shall be done neatly with factory parts and assemblies approved for the application. Provide equipment supplier with information of existing equipment, including serial number, date of manufacture, and
special requirements. Modification shall in no way jeopardize the compliance of existing equipment with governing codes, underwriters listings or other regulations.

B. Field verify existing equipment with submittals to ensure modifications are workable. Report to the Engineer discrepancies between designed requirements and existing conditions.

C. Modifications that are not factory approved shall be submitted to the Engineer for review prior to modification.

D. All new and modified electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers, that are in other than dwelling occupancies, and are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment per NFPA 70 NEC, Article 110.16.

3.04 EXISTING EQUIPMENT

A. Existing equipment that is removed and is to be reused shall be cleaned and serviced before being reinstalled.

B. Existing luminaires that are to be removed and are to be reused shall be cleaned, relamped, relensed, and reballasted prior to reinstallation.

C. Revised distribution equipment shall have new identification plates indicating new conditions.

D. Panelboards which have circuits affected by work shall be completely circuit traced and the panelboard directories updated with the room and load served (i.e., RCPT-B250 through B260, LTG-A65-A75, COFFEE-C180, RCPT-ROOF, etc.).

E. Revised panelboard schedules shall be neatly typed on new cards and installed in each revised panelboard.

F. Where remodeling interferes with existing circuits and equipment which is not to be removed, such circuits and equipment shall be reworked and relocated as required to complete the Project. Circuit integrity of equipment in adjacent areas shall be left intact.

3.05 PREPARATION

A. Cutting, Patching, Openings, Sleeves, Inserts and Hangers.
   1. Furnish and install sleeves and boxes required for openings in the structure for installation of electrical work. Be responsible for proper placement of sleeves and boxes.
   2. Provide inserts and hangers required to support conduit, cables, boxes, fixtures, etc. Provide independent support for all electrical equipment.
   3. Properly size and locate holes and chases required for work under this Division as construction progresses. Before beginning sleeving or installation work,
carefully study Contract Drawings and check conduit, boxes and equipment locations for interference with other trades. If conflicts are discovered in Drawings or as work progresses, a set of prints marked with red pencil showing recommended installation methods shall be submitted to the Architect for review prior to installation. Cutting, repairing and required structural reinforcing for installation of this work shall be done in conformance with the Architect's directions. Cutting shall not be done without the Architect's approval.

4. Cutting of concrete or other building materials shall be avoided where possible. Have a workman qualified in the electrical trade present at the pouring of concrete or the building of masonry containing electrical work to avoid cutting of concrete or other building material.

5. Sleeves and chases are prohibited in structural members except where approved by the Architect in writing. If openings necessary for this work are not installed at the time of construction, or if an opening is required in existing construction, provide the opening.

6. Patching in every instance consists of completing the work to match and blend in with the adjoining existing work insofar as methods, materials and colors, and workmanship are concerned. Patches which are not properly blended shall be rejected and ordered redone. Execute patching in full compliance with the provision of the Specifications relating to the type of work involved by craftsmen qualified and skilled in the particular type of work involved.

7. Openings for electrical work shall be carefully caulked or grouted as required. Spare conduits shall be tightly capped.

8. Holes and voids created to extend electrical systems through fire rated floors, walls, and ceilings shall be sealed with an intumescent material.

9. Costs of cutting and patching caused by improper coordination shall be paid for by the Contractor regardless of the responsibilities set forth in these Contract Documents for new work.

B. Equipment received from manufacturer with a prime coat of paint shall be cleaned, sanded and furnished with a final coat of paint.

C. Panelboards, disconnects, and boxes for life safety systems including emergency power and fire alarm equipment shall be painted red.

3.06 INSTALLATION

A. Install in accordance with manufacturer's instructions, unless local codes or regulations take precedence.

B. Install so that equipment can be easily serviced. Maintain, as a minimum, code required clearances.

C. Place or replace equipment identification in locations where they can be seen and read without difficulty.

D. Perform work in accordance with good commercial practice. The appearance of the finished work shall be of equal importance to its operation.

E. Installation of work shall be observed by the Architect. Work found to be in non compliance with the specifications shall be redone. The Architect shall be consulted
for direction for questions regarding suitability of the installed work. The Architect shall be notified at least one week prior to the covering up of work so that observation of work may be scheduled. Work shall not be covered up or enclosed until work has been tested by Contractor and has been observed by proper authorities including State/local inspectors and Architect. Should work be covered up or enclosed before such observation or test, it shall be uncovered, tested and reviewed and shall be restored by Contractor to finished condition at Contractor's own expense.

F. Coordination:
1. Locations of devices, outlets, etc., as shown on the Drawings are approximate unless dimensioned or otherwise noted. Where locations of devices, outlets, etc., are dimensioned or noted on the Drawings, verify location with Architect's representative or with equipment to be supplied. Exact locations of devices, outlets, etc., shall be coordinated with field conditions. Ensure that switches or other electrical devices are mounted such that they are not "trapped" behind opened doors or otherwise rendered inaccessible, regardless of locations indicated on Drawings.
2. Where locations of devices and equipment are not specifically mentioned in the specifications or indicated on the Drawings, verify locations with Architect and Engineer prior to rough-in.
3. Prior to rough-in for service to equipment furnished or provided by others, coordinate with other trades and Owner to verify rough in locations, connection requirements, electrical service to equipment size and characteristics, and obtain a schedule of equipment electrical loads. Schedules shall be for verifying electrical services, controls, disconnects, fuses, and overload protection. Coordinate with Architect, authority having jurisdiction, and other appropriate Divisions as needed.
4. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Architect and Engineer prior to roughing in if conflicts appear. Be responsible for coordination of equipment to the available space and to the access routes through the construction. Confer and cooperate with other trades and coordinate the work in proper relation with theirs. Coordinate ceiling cavity space carefully with other trades.

G. Refer to Division 22 & 23 Mechanical and Plumbing drawings & specifications for coordination of electrical work with mechanical and plumbing work.
1. Unless otherwise noted, provide 120 volt wiring to nearest panelboard, including circuit breaker, conduit, wire and connections for new mechanical equipment control panels, and accessory equipment. Coordinate quantity and location with Division 23.

H. All ground or floor-mounted electrical distribution equipment, including switchboards, distribution panels, motor control centers, transfer switches, generators, and transformers, shall be installed and firmly anchored to a 4 inch high concrete housekeeping pad. Pad shall extend no more than 2 inches beyond the equipment footprint.

I. Interface With Other Work:
1. Unless otherwise noted, provide 120 volt wiring to nearest panelboard, including circuit breaker, conduit, wire, and connections for magnetic door holders, fire
smoke dampers, and fire alarm system remote power supplies. Provide control
circuitry from the fire alarm control panel. Coordinate quantity and location of fire
smoke dampers with Division 23.

2. Other Communications Systems Raceways and Cable Supports: Provide a complete system of raceways, cable supports, and outlets for the future installation of a communications system.
   a. Wall outlets shall be standard double gang boxes with single gang trim
      rings and cover plate of same design and finish as specified herein.
   b. Cable supports in quantity and routing indicated shall be 2 inch diameter
      galvanized wide base CableCat J-hooks as manufactured by Caddy.
      Provide cable support mounting accessories as required.
   c. Communication system raceway and cable support routing shall maintain
      18 inches of clearance from luminaires while crossing perpendicular to
      lighting circuitry, maintain 12 inches clearance from power feeders and
      branch circuits, and maintain 4 feet clearance from motors and
      transformers. Conduits shall be sized as indicated or required with 3/4
      inch as a minimum and include a #200 nylon pull cord. Conduit runs shall
      not have more than the equivalent of three 90 degree bends between
      outlets or pull boxes. Conduit ends shall be bushed.

3.07 REPAIR
   A. Scratched, chipped, or otherwise marred electrical equipment shall be repainted to
      match original finish at no additional cost to the Owner.

3.08 RE-INSTALLATION
   A. Store and protect all equipment, devices or lighting shown on plans to be relocated,
      during demolition and new construction. Re-install and reconnect in new locations
      shown. Extend and reconnect circuitry, controls and conduit as necessary for complete
      operation.

3.09 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Arrange and oversee inspections by governing authorities. Upon completion of the
      work, deliver certificates of inspection and final approval to the Architect.
   C. Testing of electrical systems shall be in accordance with the manufacturer's
      recommendations and in accordance with applicable codes and standards for that
      system as required and as referenced in this Specification.
   D. Provide manufacturer's field representative to inspect as required and as referenced in
      this Specification.
   E. Project site testing of equipment prior to installation, where called for in the
      specifications, shall include performance testing to establish the applicability of
      equipment for its intended purpose. Where required, Installer shall:
1. Establish required test procedures from required standard or manufacturer's recommendation.
2. Provide necessary test equipment, power, consumables to perform test.
3. Notify Architect and Engineer of test schedules at least one week in advance of testing.
4. Perform tests.
5. Provide necessary documentation to Architect and Engineer.

3.10 SYSTEM STARTUP

A. Final testing and start-up of electrical systems shall include the testing and checkout of equipment and systems to establish their proper capacity, operation, maintenance and code compliance. Where required, Installer shall:
   1. Provide manufacturer's field representative to perform systems startup.
   2. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.
   3. Provide necessary test equipment, power, consumables to perform tests.
   4. Notify Architect of test ans start-up schedules at least one week in advance.
   5. Provide necessary documentation of completed tests and fully functional systems to Architect.

B. Load balance test the distribution system. Unbalance between phases shall not exceed 10% with full lighting and mechanical loads. Correct unbalanced load conditions exceeding this limit. Corrections shall be indicated on Record Drawings.

3.11 ADJUSTING

A. Adjust for proper operation within manufacturer's published tolerances.

3.12 CLEANING

A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

B. At the conclusion of each day's work, remove empty boxes, crates and rubbish and leave the area where the work has been done broom clean.

C. On completion of work, remove tools, scaffolding, debris, etc., from the grounds and leave the premises perfectly clean. Equipment and facilities shall be thoroughly cleaned inside and out and residue removed. Equipment shall be turned over to the Owner in perfect, unblemished condition. Remove temporary labels and stickers

3.13 COMMISSIONING

A. See Section 01 91 13 - General Commissioning Requirements, for commissioning requirements.

B. See Section 26 08 00 - Commissioning of Electrical Systems, for commissioning requirements in accordance with IECC.
C. See Section 26 08 11 - Commissioning of Lighting and Lighting Controls Systems, for commissioning requirements in accordance with IECC.

D. Coordinate with USGBC LEED consultant and (CxA) commissioning agent all requirements, documentation, installation procedures, and commissioning requirements.

3.14 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. Demonstration: Demonstrate operation of system to Owner's personnel.
   1. Use operation and maintenance data as reference during demonstration.
   2. Briefly describe function, operation, and maintenance of each component.

E. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer's training personnel.
   4. Location: At project site.
   5. Location: Owner's offsite classroom facilities may be used.

F. Upon written request from the Contractor certifying that the work is complete and ready for inspection, the Engineer shall prepare punchlist of items determined to be incomplete or otherwise not in compliance with intent of Contract Documents.

G. When required, subsequent visit to review completion of punchlist work shall be made after receipt of written statement from Contractor indicating punchlist work is complete. Include copies of intermediate observation reports and final punchlists with individual items initialed by Contractor to attest that individual work items are completed.

H. Contractor shall pay Engineer's costs at the billing rates in effect at the time the services are performed for subsequent punchlist visits required due to lack of completion of prior punchlist.

3.15 PROTECTION

A. Protect installed materials and equipment from subsequent construction operations.

B. After tests and adjustments have been made and systems pronounced satisfactory for permanent operation, refinish damaged finish and leave everything in proper working order and of the intended appearance at the final completion of the Contract.

C. Reestablish original grades, landscaping, and other grade finishes.
3.16 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide testing and maintenance of equipment and systems per manufacturer’s requirements during warranty period to adhere to warranty requirements

END OF SECTION
SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.
B. Nonmetallic-sheathed cable.
C. Underground feeder and branch-circuit cable.
D. Service entrance cable.
E. Armored cable.
F. Metal-clad cable.
G. Manufactured wiring systems.
H. Wiring connectors.
I. Electrical tape.
J. Heat shrink tubing.
K. Oxide inhibiting compound.
L. Wire pulling lubricant.
M. Cable ties.

1.02 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
E. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conductors.
F. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.
G. Section 31 23 16 - Excavation.

I. Section 31 23 23 - Fill: Bedding and backfilling.

1.03 REFERENCE STANDARDS


I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

J. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; 2012.

K. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.

L. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); 2007.


O. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. UL 4 - Armored Cable; Current Edition, Including All Revisions.

R. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All
Revisions.
U. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
W. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current
X. UL 719 - Nonmetallic-Sheathed Cables; Current Edition, Including All Revisions.
Y. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.
Z. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under
      other sections with the actual conductors to be installed, including adjustments
      for conductor sizes increased for voltage drop.
   2. Coordinate the installation of direct burial cable with other trades to avoid
      conflicts with piping or other potential conflicts.
   3. Coordinate with electrical equipment installed under other sections to provide
      terminations suitable for use with the conductors to be installed.
   4. Notify Architect of any conflicts with or deviations from the contract documents.
      Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for
   conductors and cables, including detailed information on materials, construction,
   ratings, listings, and available sizes, configurations, and stranding.
C. Sustainable Design Documentation: Submit manufacturer's product data on conductor
   and cable showing compliance with specified lead content requirements.
D. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed
   system layout with components identified; indicate branch circuit connections.
E. Design Data: Indicate voltage drop and ampacity calculations for aluminum
   conductors substituted for copper conductors. Include proposed modifications to
   raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted
   conductors.
F. Field Quality Control Test Reports.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
   1. Exceptions:
a. Use manufactured wiring systems for branch circuits where concealed under raised floors.
   1. Exception: Provide single conductor building wire in raceway for circuit homerun from distribution box to panelboard.

b. Use power and control tray cable or metal-clad cable for installation in cable tray.

C. Nonmetallic-sheathed cable is not permitted.
   1. Where not otherwise restricted, may be used:
      a. For branch circuit wiring in dry locations within one- and two-family dwellings and their attached or detached garages, and their storage buildings.
      b. For branch circuit wiring in dry locations within multifamily dwellings permitted to be of Types III, IV, and V construction.

   2. In addition to other applicable restrictions, may not be used:
      a. Where exposed to view.
      b. Where exposed to damage.
      c. For damp, wet, or corrosive locations.

D. Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is not permitted.
   1. Where not otherwise restricted, may be used:
      a. For overhead service drop, installed in raceway to service head.
      b. For underground service entrance, installed in raceway.

   2. In addition to other applicable restrictions, may not be used:
      a. Where exposed to damage.

F. Armored cable is not permitted.
   1. Where not otherwise restricted, may be used:
      a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
         1. Maximum Length: 6 feet.
      b. Where concealed in hollow stud walls and under raised floors for branch circuits up to 20 A.
         1. Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
      c. For general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities, when provided with additional insulated grounding conductor for redundant grounding.

   2. In addition to other applicable restrictions, may not be used:
      a. Unless approved by Owner.
      b. Where not approved for use by the authority having jurisdiction.
      c. Where exposed to view.
      d. Where exposed to damage.
      e. For damp, wet, or corrosive locations.
      f. For isolated ground circuits.

G. Metal-clad cable is permitted only as follows:

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LOW-VOLTAGE ELECTRICAL  POWER CONDUCTORS AND  CABLES
1. Where not otherwise restricted, may be used:
   a. Where concealed above accessible ceilings for final connections from
      junction boxes to luminaires.
      1. Maximum Length: 12 feet.
   b. Where concealed in hollow stud walls and under raised floors for branch
      circuits up to 20 A.
      1. Exception: Provide single conductor building wire in raceway for
         circuit homerun from first outlet to panelboard.

2. In addition to other applicable restrictions, may not be used:
   a. Unless approved by Owner.
   b. Where not approved for use by the authority having jurisdiction.
   c. Where exposed to view.
   d. Where exposed to damage.
   e. For damp, wet, or corrosive locations, unless provided with a PVC jacket
      listed as suitable for those locations.
   f. For isolated ground circuits, unless provided with an additional
      isolated/insulated grounding conductor.
   g. For patient care areas of health care facilities requiring redundant
      grounding.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide new conductors and cables manufactured not more than one year prior to
   installation.

D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring,
   connectors, etc. as required for a complete operating system.

E. Comply with NEMA WC 70.

F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying
   with UL 83.

G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with
   UL 44.

H. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

I. Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for
   cable tray use.

J. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and
   labeled as sunlight resistant.

K. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only
   where specifically permitted): Plenum rated, listed and labeled as suitable for use in
   return air plenums.
L. Conductor Material:
1. Provide copper conductors except where aluminum conductors are specifically indicated. Substitution of aluminum conductors for copper is not permitted. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.
4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

M. Minimum Conductor Size:
1. Branch Circuits: 12 AWG.
   a. Exceptions:
      1. 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
      2. 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
      3. 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
2. Control Circuits: 14 AWG.
3. Wire sizes for other branch circuits shall be sized to limit voltage drop to 3%.

N. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

O. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
   a. 480Y/277 V, 3 Phase, 4 Wire System:
      1. Phase A: Brown.
      2. Phase B: Orange.
      3. Phase C: Yellow.
   b. 208Y/120 V, 3 Phase, 4 Wire System:
      1. Phase A: Black.
      2. Phase B: Red.
      3. Phase C: Blue.
   c. 240/120 V High-Leg Delta, 3 Phase, 4 Wire System:
      1. Phase A: Black.
      2. Phase B (High-Leg): Orange.
      3. Phase C: Blue.
   d. 240/120 V, 1 Phase, 3 Wire System:
1. Phase A: Black.
2. Phase B: Red.
e. Equipment Ground, All Systems: Green.
f. Isolated Ground, All Systems: Green with yellow stripe.
g. Travelers for 3-Way and 4-Way Switching: Pink.
h. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
i. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
   1. Copper Building Wire:
   2. Aluminum Building Wire (only where specifically indicated or permitted for substitution):
      c. Stabiloy, a brand of General Cable Technologies Corporation; ______: www.stabiloy.com/#sle.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:
   1. Feeders and Branch Circuits:
      b. Size 8 AWG and Larger: Stranded.
   2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:
   1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
      a. Size 4 AWG and Larger: Type XHHW-2.
      c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.
   2. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.
2.04 NONMETALLIC-SHEATHED CABLE

A. Manufacturers:

B. Description: NFPA 70, Type NM multiple-conductor cable listed and labeled as complying with UL 719, Type NM-B.

C. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

2.05 SERVICE ENTRANCE CABLE

A. Manufacturers:
   1. Copper Service Entrance Cable:
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Aluminum Service Entrance Cable:
      c. Stabiloy, a brand of General Cable Technologies Corporation; ______: www.stabiloy.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

B. Service Entrance Cable for Above-Ground Use: NFPA 70, Type SE multiple-conductor cable listed and labeled as complying with UL 854, Style R.

C. Service Entrance Cable for Underground Use: NFPA 70, Type USE single-conductor cable listed and labeled as complying with UL 854, Type USE-2, and with UL 44, Type RHH/RHW-2.

D. Conductor StrANDING: Stranded.

E. Insulation Voltage Rating: 600 V.

2.06 ARMORED CABLE

A. Manufacturers:
   1. AFC Cable Systems Inc: www.afcweb.com/#sle.
B. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN.

F. Grounding: Combination of interlocking armor and integral bonding wire.
   1. Provide additional full-size integral insulated equipment grounding conductor for redundant grounding, suitable for general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities.

G. Armor: Steel, interlocked tape.

2.07 METAL-CLAD CABLE

A. Manufacturers:
   1. AFC Cable Systems Inc: www.afcweb.com/#sle.

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Provide oversized neutral conductors where indicated or required.

G. Provide dedicated neutral conductor for each phase conductor where indicated or required.

H. Grounding: Full-size integral equipment grounding conductor.
   1. Provide additional isolated/insulated grounding conductor where indicated or required.

I. Armor: Steel, interlocked tape.

J. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.
2.08 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.

C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
   2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors.

D. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
   3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
   4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
   5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
   6. Aluminum Conductors: Use compression connectors for all connections.
   7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
   8. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      c. NSI Industries LLC: www.nsiindustries.com/#sle.

H. Mechanical Connectors: Provide bolted type or set-screw type.
   1. Manufacturers:

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:

2.09 WIRING ACCESSORIES

A. Electrical Tape:
1. Manufacturers:
   a. 3M: www.3m.com/#sle.
2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
   a. 3M: www.3m.com/#sle.
b. Burndy LLC; ______: www.burndy.com/#sle.


C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
   1. Manufacturers:

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.

E. Cable Ties: Material and tensile strength rating suitable for application.
   1. Manufacturers:

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
   a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
   b. Increase size of conductors as required to account for ampacity derating.
   c. Size raceways, boxes, etc. to accommodate conductors.
8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
9. Provide oversized neutral/grounded conductors where indicated and as specified below.
   a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
   b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.

B. Install products in accordance with manufacturer's instructions.
C. Perform work in accordance with NECA 1 (general workmanship).
D. Install aluminum conductors in accordance with NECA 104.
E. Install nonmetallic-sheathed cable (Type NM-B) in accordance with NECA 121.
F. Install underground feeder and branch-circuit cable (Type UF-B) in accordance with NECA 121.
G. Install armored cable (Type AC) in accordance with NECA 120.
H. Install metal-clad cable (Type MC) in accordance with NECA 120.
I. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
J. Exposed Cable Installation (only where specifically permitted):
   1. Route cables parallel or perpendicular to building structural members and surfaces.
2. Protect cables from physical damage.

K. Direct Burial Cable Installation:
   1. Provide trenching and backfilling in accordance with Section 31 23 16.13 - Trenching.
   2. Install cable with minimum cover of 24 inches unless otherwise indicated or required.
   3. Protect cables from damage in accordance with NFPA 70.
   4. Provide underground warning tape in accordance with Section 26 05 53 along entire cable length.

L. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

M. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
   1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

N. Terminate cables using suitable fittings.
   1. Armored Cable (Type AC):
      a. Use listed fittings and anti-short, insulating bushings.
      b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
      c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.
   2. Metal-Clad Cable (Type MC):
      a. Use listed fittings.
      b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
      c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.

O. Install conductors with a minimum of 12 inches of slack at each outlet.

P. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

Q. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

R. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

S. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

T. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
      b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.

U. Insulate ends of spare conductors using vinyl insulating electrical tape.

V. Identify conductors and cables in accordance with Section 26 05 53.

W. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

X. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Grounding and bonding requirements.
B. Conductors for grounding and bonding.
C. Connectors for grounding and bonding.
D. Ground bars.
E. Ground rod electrodes.
F. Chemically-enhanced ground electrodes.
G. Ground plate electrodes.
H. Ground enhancement material.
I. Ground access wells.
J. Pre-fabricated signal reference grids.

1.02  RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
   1. Includes oxide inhibiting compound.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
C. Section 26 56 00 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03  REFERENCE STANDARDS

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. For signal reference grids, coordinate the work with access flooring furnished in accordance with Section 09 69 00.
4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for grounding and bonding system components.
C. Shop Drawings:
1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.
D. Manufacturer’s Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. Field quality control test reports.
F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer’s instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
   3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

F. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Metal Underground Water Pipe(s):
a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Metal In-Ground Support Structure:
a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.

4. Concrete-Encased Electrode:
a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

5. Ground Rod Electrode(s):
a. Provide single electrode unless otherwise indicated or required.
b. Space electrodes not less than 10 feet from each other and any other ground electrode.
c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
d. Provide ground enhancement material around electrode where indicated.
e. Provide ground access well for each electrode.

6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
a. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.
b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

8. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.

G. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not
make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
   a. Transformers (except autotransformers such as buck-boost transformers).
   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
   c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.

4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
   b. Metal gas piping.
   c. Metal process piping.

8. Provide bonding for interior metal air ducts.


10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.

11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.

12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.

K. Isolated Ground System:
   1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
   2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
   3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

L. Communications Systems Grounding and Bonding:
   1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
   2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
      a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
      b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
      c. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.
      d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
M. Signal Reference Grids:
1. Provide signal reference grid on subfloor under access floors where indicated.
2. Construct grid using field-welded sections of pre-fabricated signal reference grids.
3. Unless otherwise indicated, locate grid between 6 and 18 inches (150 and 450 mm) from perimeter walls.
4. Unless otherwise indicated, make bonding connections to signal reference grid using exothermic welded connections.
5. Make bonding connections as short as possible, with no sharp folds or bends.
6. Unless otherwise indicated, provide separate bonding connections from signal reference grid to each item to be bonded. Do not daisy chain items together to facilitate single point connection to signal reference grid.
7. Provide 6 AWG bonding jumper to connect every sixth access floor pedestal in each direction to signal reference grid. Make connections to floor pedestals using exothermic welded connections.
8. Provide 6 AWG bonding jumper to connect each steel column within and at the perimeter of room to signal reference grid. Make connections to steel columns using exothermic welded connections.
9. Provide 6 AWG bonding jumper to connect each metal item such as conduits, pipes, ducts, etc. crossing the plane of, or within 6 feet (1.8 m) of, the signal reference grid. Make connections to conduits and pipes using listed ground clamps.
10. Provide 6 AWG bonding jumper to connect signal reference grid to grounding point of separately derived systems serving equipment located on the signal reference grid.
11. Provide low impedance risers to connect each equipment enclosure to signal reference grid. For each piece of equipment, provide two separate connections of different lengths connected to opposite sides of equipment and to different points on the signal reference grid. Make connections to equipment enclosures using mechanical connectors. Do not make connection to signal reference grid on the outermost grid conductor.
12. Provide transient suppression plates on floor beneath items indicated. Provide 6 AWG bonding jumper to connect transient suppression plate to signal reference grid.
   a. Transient Suppression Plates: Constructed from 26 gage sheet copper, 4 by 4 feet unless otherwise indicated.

N. Pole-Mounted Luminaires: Also comply with Section 26 56 00.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
1. Use insulated copper conductors unless otherwise indicated.
   a. Exceptions:
      1. Use bare copper conductors where installed underground in direct contact with earth.
      2. Use bare copper conductors where directly encased in concrete (not in raceway).

2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gage of specified conductors.

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   a. Exceptions:
      1. Use mechanical connectors for connections to electrodes at ground access wells.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
   a. Exceptions:
      1. Use exothermic welded connections for connections to metal building frame.
4. Manufacturers - Mechanical and Compression Connectors:
   a. Advanced Lightning Technology (ALT); ______: www.altfab.com/#sle.
   b. Burndy LLC; _____: www.burndy.com/#sle.
   c. Harger Lightning & Grounding; ___________: www.harger.com/#sle.
   d. Thomas & Betts Corporation; ______: www.tnb.com/#sle.
5. Manufacturers - Exothermic Welded Connections:
   c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; ___________: www.thermoweld.com/#sle.

D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:
   a. Advanced Lightning Technology (ALT); _____: www.altfab.com/#sle.
   c. Harger Lightning & Grounding; ___________: www.harger.com/#sle.
   d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; ___________: www.thermoweld.com/#sle.

E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.
5. Manufacturers:
   a. Advanced Lightning Technology (ALT); ______: www.altfab.com/#sle.
   d. Harger Lightning & Grounding; ________: www.harger.com/#sle.

F. Chemically-Enhanced Ground Electrodes:
   1. Description: Copper tube factory-filled with electrolytic salts designed to provide a low-impedance ground in locations with high soil resistivity; straight (for vertical installations) or L-shaped (for horizontal installations) as indicated or as required.
   2. Length: 10 feet.
   3. Integral Pigtail: Factory-attached, sized not less than grounding electrode conductor to be attached.
   4. Backfill Material: Grounding enhancement material recommended by electrode manufacturer.
5. Manufacturers:
   a. Advanced Lightning Technology (ALT); ______: www.altfab.com/#sle.
   c. Harger Lightning & Grounding; ______: www.harger.com/#sle.

G. Ground Plate Electrodes:
   1. Material: Copper.
   2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.
3. Manufacturers:
   a. Advanced Lightning Technology (ALT); ______: www.altfab.com/#sle.
   c. Harger Lightning & Grounding; ______: www.harger.com/#sle.

H. Ground Enhancement Material:
   1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
   2. Resistivity: Not more than 20 ohm-cm in final installed form.
3. Manufacturers:
   b. Harger Lightning & Grounding; ______: www.harger.com/#sle.

I. Ground Access Wells:
   1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
   a. Areas Exposed to Vehicular Traffic: Rated for not less than _____ pounds vertical design load.
   2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
   a. Round Wells: Not less than 8 inches in diameter.
   b. Rectangular Wells: Not less than 12 by 12 inches.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
4. Cover: Factory-identified by permanent means with word "GROUND".
5. Manufacturers:
   a. Advanced Lightning Technology (ALT); ______: www.altfab.com/#sle.
   c. Harger Lightning & Grounding; ________: www.harger.com/#sle.

J. Oxide Inhibiting Compound: Comply with Section 26 05 19.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.
B. Verify that field measurements are as indicated.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
   2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.
E. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

F. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION
SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02  RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
C. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
D. Section 26 25 13 - Low-Voltage Busways: Additional support and attachment requirements for busway.
E. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
F. Section 26 51 33 - Luminaires, Ballasts, and Drivers - Lutron: Additional support and attachment requirements for luminaires.
G. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03  REFERENCE STANDARDS
D. MFMA-4 - Metal Framing Standards Publication; 2004.
E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

E. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 10. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.

C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.
   3. Manufacturers:
      d. Thomas & Betts Corporation; __________: www.tnb.com/#sle.

D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
   1. Manufacturers:
a. Cooper Crouse-Hinds, a division of Eaton Corporation; _________:  
www.cooperindustries.com/#sle.
c. O-Z/Gedney, a brand of Emerson Electric Co; _________:  
www.emerson.com/#sle.
d. Thomas & Betts Corporation; _________:  www.tnb.com/#sle.

E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   2. Channel (Strut) Used as Raceway (only where specifically indicated):  Listed and labeled as complying with UL 5B.
   3. Channel Material:
      a. Indoor Dry Locations:  Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations:  Use galvanized steel.
   4. Minimum Channel Thickness:  Steel sheet, 12 gage, 0.1046 inch.
   6. Manufacturers:
      a. Cooper B-Line, a division of Eaton Corporation; _________:  
www.cooperindustries.com/#sle.
      c. Unistrut, a brand of Atkore International Inc; _________:  
www.unistrut.com/#sle.
      d. Source Limitations:  Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

F. Hanger Rods:  Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports:  1/2 inch diameter.
      b. Busway Supports:  1/2 inch diameter.
      c. Single Conduit up to 1 inch (27 mm) trade size:  1/4 inch diameter.
      d. Single Conduit larger than 1 inch (27 mm) trade size:  3/8 inch diameter.
      e. Trapeze Support for Multiple Conduits:  3/8 inch diameter.
      f. Outlet Boxes:  1/4 inch diameter.
      g. Luminaires:  1/4 inch diameter.

G. Non-Penetrating Rooftop Supports for Low-Slope Roofs:  Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
   1. Base Sizes:  As required to distribute load sufficiently to prevent indentation of roofing assembly.
   2. Attachment/Support Fixtures:  As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
   3. Mounting Height:  Provide minimum clearance of 6 inches under supported component to top of roofing.
   4. Manufacturers:
d. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.

H. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners are not permitted.
11. Hammer-driven anchors and fasteners are not permitted.
   a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction (when specified).
   b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction (when specified).
12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   b. Channel Material: Use galvanized steel.
   c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
   d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
13. Manufacturers - Mechanical Anchors:
   b. ITW Red Head, a division of Illinois Tool Works, Inc; __________: www.itwredhead.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Field-Welding (where approved by Architect): Comply with Section 05 50 00.

I. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
   5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

J. Conduit Support and Attachment: Also comply with Section 26 05 33.13.

K. Box Support and Attachment: Also comply with Section 26 05 33.16.

L. Busway Support and Attachment: Also comply with Section 26 25 13.

M. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.

N. Exterior Luminaire Support and Attachment: Also comply with Section 26 56 00.

O. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

P. Secure fasteners according to manufacturer's recommended torque settings.

Q. Remove temporary supports.
R. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).
B. Aluminum rigid metal conduit (RMC).
C. Intermediate metal conduit (IMC).
D. PVC-coated galvanized steel rigid metal conduit (RMC).
E. Flexible metal conduit (FMC).
F. Liquidtight flexible metal conduit (LFMC).
G. Electrical metallic tubing (EMT).
H. Rigid polyvinyl chloride (PVC) conduit.
I. Electrical nonmetallic tubing (ENT).
J. Liquidtight flexible nonmetallic conduit (LFNC).
K. Reinforced thermosetting resin conduit (RTRC).
L. Conduit fittings.
M. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.
B. Section 07 84 00 - Firestopping.
C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.
E. Section 26 05 29 - Hangers and Supports for Electrical Systems.
F. Section 26 05 33.23 - Surface Raceways for Electrical Systems.
G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
H. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.
I. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems conduits.

J. Section 31 23 16 - Excavation.


L. Section 31 23 23 - Fill: Bedding and backfilling.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.


D. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.

E. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

F. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005 (R2013).

G. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.

H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.

I. NEMA TC 13 - Electrical Nonmetallic Tubing (ENT); 2014.

J. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series; 2015.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

M. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.


O. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

P. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

Q. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

R. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
   4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Shop Drawings:
   1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
   2. Include proposed locations of roof penetrations and proposed methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
   5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
   6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
   7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.

D. Embedded Within Concrete:
   1. Within Slab on Grade: Not permitted.
   2. Within Slab Above Ground: Not permitted.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

5. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
   1. Locations subject to physical damage include, but are not limited to:
      a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
      b. Where exposed below 20 feet in warehouse areas.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

M. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit, aluminum rigid metal conduit, or reinforced thermosetting resin conduit (RTRC).
   1. Corrosive locations include, but are not limited to:
      a. Cooling towers.

N. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), aluminum rigid metal conduit, or PVC-coated galvanized steel rigid metal conduit.

O. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
   1. Maximum Length: 6 feet.

P. Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
   a. Transformers.
   b. Motors.

Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.02 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Electrical Service Conduits: Also comply with Section 26 21 00.

C. Communications Systems Conduits: Also comply with Section 27 10 00.

D. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.

E. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

F. Provide products listed, classified, and labeled as suitable for the purpose intended.

G. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 1/2 inch (16 mm) trade size.
   2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
   3. Control Circuits: 1/2 inch (16 mm) trade size.
   4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
   5. Underground, Interior: 3/4 inch (21 mm) trade size.
   6. Underground, Exterior: 1 inch (27 mm) trade size.

H. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
   1. Manufacturers:
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
4. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:
   1. Manufacturers:
   2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
   5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
   1. Manufacturers:
   2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
4. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.06 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

D. Interior Coating: Urethane, minimum thickness of 2 mil.

E. PVC-Coated Fittings:
   1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
   2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
   3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
   4. Material: Use steel or malleable iron.
   5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.

F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.07 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
   1. AFC Cable Systems, Inc; ______: www.afcweb.com/#sle.
   2. Electri-Flex Company; ______: www.electriflex.com/#sle.
   3. International Metal Hose; ______: www.metalhose.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:
   1. Manufacturers:
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.08 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
   1. AFC Cable Systems, Inc; ______: www.afcweb.com/#sle.
   2. Electri-Flex Company; ______: www.electriflex.com/#sle.
   3. International Metal Hose; ______: www.metalhose.com/#sle.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
   1. Manufacturers:
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.

2.09 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
   1. Manufacturers:
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.
   4. Connectors and Couplings: Use compression (gland) or set-screw type.
      a. Do not use indenter type connectors and couplings.
5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.11 ELECTRICAL NONMETALLIC TUBING (ENT)

A. Manufacturers:
   2. Carlon, a brand of Thomas & Betts Corporation; ______: www.carlon.com/#sle.

B. Description: NFPA 70, Type ENT electrical nonmetallic tubing complying with NEMA TC 13 and listed and labeled as complying with UL 1653.

C. Fittings:
   1. Manufacturer: Same as manufacturer of ENT to be connected.
   2. Use solvent-welded type fittings.
   3. Solvent-Welded Fittings: Rigid PVC fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; suitable for use with ENT.
   4. Snap-on Fittings: Listed and labeled as complying with UL 651.

2.12 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:
   1. AFC Cable Systems, Inc: www.afcweb.com/#sle.

B. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.13 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)
   A. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).
   B. Supports: Per manufacturer’s recommendations.
   C. Fittings: Same type and manufacturer as conduit to be connected.

2.14 ACCESSORIES
   A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
      1. Product: __________.
      2. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
   C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
   D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
   E. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
   F. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
   G. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that mounting surfaces are ready to receive conduits.
   C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer’s instructions.
   B. Perform work in accordance with NECA 1 (general workmanship).
C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

H. Install electrical nonmetallic tubing (ENT) in accordance with NECA 111.

I. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

J. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conceil all conduits unless specifically indicated to be exposed.
   4. Conduit shall be run parallel to walls, ceilings, and building lines wherever possible.
   5. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
      c. Within joists in areas with no ceiling.
   6. Unless otherwise approved, do not route conduits exposed:
      a. Across floors.
      b. Across roofs.
      c. Across top of parapet walls.
      d. Across building exterior surfaces.
   7. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
   8. Arrange conduit to maintain adequate headroom, clearances, and access.
   9. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
  10. Arrange conduit to provide no more than 150 feet between pull points.
  11. Route conduits above water and drain piping where possible.
  12. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
  13. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
  14. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
      a. Heaters.
      b. Hot water piping.
      c. Flues.
  15. Group parallel conduits in the same area together on a common rack.
K. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
9. Use of spring steel conduit clips for support of conduits is not permitted.
10. Use of wire for support of conduits is not permitted.
   a. For securing conduits to studs in hollow stud walls.
   b. For suspending conduits supported by spring steel conduit clips (only where specifically indicated or permitted).
11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

L. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

M. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
9. Provide metal escutcheon plates for conduit penetrations exposed to public view.
10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

N. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 23 16.13.
2. Minimum Cover, Unless Otherwise Indicated or Required:
   b. Under Slab on Grade: 12 inches to bottom of slab.
3. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.

O. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

P. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.

Q. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
4. Where conduits are subject to earth movement by settlement or frost.
R. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits penetrate coolers or freezers.

S. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

T. Provide grounding and bonding in accordance with Section 26 05 26.

U. Identify conduits in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
D. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING
A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION
A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION
SECTION 26 05 33.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Boxes for hazardous (classified) locations.

D. Floor boxes.

E. Underground boxes/enclosures.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 07 84 00 - Firestopping.

C. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

E. Section 26 05 29 - Hangers and Supports for Electrical Systems.

F. Section 26 05 33.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

H. Section 26 27 26 - Wiring Devices:
   1. Wall plates.
   2. Floor box service fittings.
   3. Poke-through assemblies.
   5. Additional requirements for locating boxes for wiring devices.

I. Section 26 28 13 - Fuses: Spare fuse cabinets.

J. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems outlet boxes.
1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
C. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
D. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
5. Use nonmetallic boxes where exposed rigid PVC conduit is used.
6. Use suitable concrete type boxes where flush-mounted in concrete.
7. Use suitable masonry type boxes where flush-mounted in masonry walls.
8. Use raised covers suitable for the type of wall construction and device configuration where required.
9. Use shallow boxes where required by the type of wall construction.
10. Do not use "through-wall" boxes designed for access from both sides of wall.
11. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
12. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
13. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
14. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
15. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
16. Minimum Box Size, Unless Otherwise Indicated:
   a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
   b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
   c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
17. Wall Plates: Comply with Section 26 27 26.
18. Manufacturers:
   b. Hubbell Incorporated; Bell Products; ______: www.hubbell-rtb.com/#sle.
   c. Hubbell Incorporated; RACO Products; ______: www.hubbell-rtb.com/#sle.
   e. Thomas & Betts Corporation; _________: www.tnb.com/#sle.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
a. Indoor Clean, Dry Locations: Type 1, painted steel.
b. Outdoor Locations: Type 3R, painted steel.

3. Junction and Pull Boxes Larger Than 100 cubic inches:
   a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
   b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
   a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
   c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.

5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

6. Manufacturers:
   c. Hubbell Incorporated; Wiegmann Products; ________: www.hubbell-wiegmann.com/#sle.

D. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
   1. Manufacturers:
      c. Hubbell Incorporated; Killark Products; ________: www.hubbell-killark.com/#sle.

E. Floor Boxes:
   1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
   2. Use cast iron floor boxes within slab on grade.
   3. Use sheet-steel or cast iron floor boxes within slab above grade.
   4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
   5. Manufacturer: Same as manufacturer of floor box service fittings.

F. Underground Boxes/Enclosures:
   1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
   2. Size: As indicated on drawings.
3. **Depth:** As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. **Provide logo on cover to indicate type of service.**
5. **Applications:**
   a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
   b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 15 load rating.
   c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
6. **Polymer Concrete Underground Boxes/Enclosures:** Comply with SCTE 77.
   a. **Manufacturers:**
      1. Hubbell Incorporated; Quazite Products; ______: www.hubbellpowersystems.com/#sle.
   b. Combination fiberglass/polymer concrete boxes/enclosures are not acceptable. Use all-polymer concrete boxes/enclosures.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.

**3.02 INSTALLATION**

A. Install products in accordance with manufacturer's instructions.
B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Pull and junction boxes shall be accessible.
E. Provide separate boxes for emergency power and normal power systems.
F. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
G. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

H. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

I. Box Locations:
1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
2. Unless dimensioned, box locations indicated are approximate.
3. Locate boxes as required for devices installed under other sections or by others.
   a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.
   b. Communications Systems Outlets: Comply with Section 27 10 00.
   c. Communications outlets shall be mounted at the same height as adjacent receptacle outlets unless noted otherwise.
4. Locate boxes so that wall plates do not span different building finishes.
5. Locate boxes so that wall plates do not cross masonry joints.
6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
   a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
   b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
   a. Concealed above accessible suspended ceilings.
   b. Within joists in areas with no ceiling.
   c. Electrical rooms.
   d. Mechanical equipment rooms.

J. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit.
connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

K. Install boxes plumb and level.

L. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

M. Floor-Mounted Cabinets: Mount on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.

N. Install boxes as required to preserve insulation integrity.

O. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

P. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.

Q. Underground Boxes/Enclosures:
   1. Install enclosure on gravel base, minimum 6 inches deep.
   2. Flush-mount enclosures located in concrete or paved areas.
   3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
   4. Provide cast-in-place concrete collar constructed in accordance with Section 03 30 00, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.
   5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

R. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

T. Close unused box openings.

U. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
V. Provide grounding and bonding in accordance with Section 26 05 26.

W. Identify boxes in accordance with Section 26 05 53.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION
SECTION 26 05 33.23 - SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface raceway systems.

B. Wireways.

C. Wall duct.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   1. Includes metal channel (strut) used as raceway.

C. Section 26 05 33.13 - Conduit for Electrical Systems.

D. Section 26 05 33.16 - Boxes for Electrical Systems.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

F. Section 26 27 26 - Wiring Devices: Receptacles.

G. Section 27 10 00 - Structured Cabling: Voice and data jacks.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA PRP 5 - Installation Guidelines for Surface Nonmetallic Raceway; 2015.

E. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.

F. UL 5A - Nonmetallic Surface Raceways and Fittings; Current Edition, Including All Revisions.


1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate rough-in locations of outlet boxes provided under Section 26 05 33.16 and conduit provided under Section 26 05 33.13 as required for installation of raceways provided under this section.
3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
4. Wall Duct: Coordinate the work with other trades to provide walls suitable for installation of flush-mounted wall duct where indicated.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install raceways until final surface finishes and painting are complete.
   2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
   1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

C. Shop Drawings:
   1. Pre-wired Surface Raceway Systems: Provide plan and elevation views including dimensioned locations of wiring devices and circuiting arrangements.
   2. Wireways: Provide dimensioned plan and elevation views including adjacent equipment with all required clearances indicated.

D. Samples: Three of each type and color of surface raceway system specified, 6 inches in length.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 RACEWAY REQUIREMENTS
A. Provide all components, fittings, supports, and accessories required for a complete raceway system.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.02 SURFACE RACEWAY SYSTEMS
A. Manufacturers:
   2. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
B. Surface Metal Raceways: Listed and labeled as complying with UL 5.
C. Surface Nonmetallic Raceways: Listed and labeled as complying with UL 5A.
D. Multioutlet Assemblies: Listed and labeled as complying with UL 111.
E. Metal Channel (Strut) Used as Raceway: Comply with Section 26 05 29.
F. Type _____ - Surface Raceway System:
   1. Raceway Type: Single channel, painted steel.
   2. Size: _____ by _____ inches.
   3. Length: As indicated on the drawings.
   4. Color: To be selected by Architect.
   5. Accessory Device Boxes: Suitable for the devices to be installed; color to match raceway.
   6. Integrated Device Provisions:
      a. Receptacles:
         1. Comply with Section 26 27 26, except for finishes.
         2. Configuration: As indicated on the drawings.
         4. Spacing: As indicated on the drawings.
b. Communications Outlets:
   1. Voice and Data Jacks: Include provisions for jacks furnished by others.
   2. Configuration: As indicated on the drawings.
   3. Spacing: As indicated on the drawings.

2.03 WIREWAYS

A. Manufacturers:
   1. Cooper B-Line, a division of Cooper Industries; ______: www.cooperindustries.com/#sle.
   3. Schneider Electric; Square D Products; ______: www.schneider-electric.us/#sle.

B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.

C. Wireway Type, Unless Otherwise Indicated:
   1. Indoor Clean, Dry Locations: NEMA 250, Type 1, painted steel with screw-cover.
   2. Outdoor Locations: NEMA 250, Type 3R, painted steel with screw-cover; include provision for padlocking.

D. Finish for Painted Steel Wireways: Manufacturer's standard grey unless otherwise indicated.

E. Minimum Wireway Size: 4 by 4 inches unless otherwise indicated.

F. Where wireway size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.04 WALL DUCT

A. Manufacturers:
   1. Dennis Filges Company, Inc; ______: www.filgesco.com/#sle.
   2. Schneider Electric; Square D Products; ______: www.schneider-electric.us/#sle.
   3. Wiremold, a brand of Legrand North America, Inc; ______: www.legrand.us/#sle.
   4. Source Limitations: Where the wall duct system includes connections to trench duct as specified in Section 26 05 39, furnish wall duct and associated components produced by the same manufacturer as the trench duct to be installed.

B. Description: Metal raceways specifically designed for enclosure of wiring to X-ray machines and similar medical equipment; listed and labeled as complying with UL 870.

C. Material: Steel, unless otherwise indicated.

D. Mounting Provisions: Suitable for surface- or flush-mounting as indicated.

E. Size: As indicated on the drawings.
2.05 SOURCE QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Factory test each production unit for pre-wired surface raceway systems to verify proper wiring.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.
   C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Perform work in accordance with NECA 1 (general workmanship).
   C. Surface Nonmetallic Raceways: Install in accordance with NEMA PRP 5.
   D. Install raceways plumb and level.
   E. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.
   F. Secure and support raceways in accordance with Section 26 05 29 at intervals complying with NFPA 70 and manufacturer's requirements.
   G. Close unused raceway openings.
   H. Provide grounding and bonding in accordance with Section 26 05 26.
   I. Identify raceways in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Inspect raceways for damage and defects.
   C. Surface Raceway Systems with Integrated Devices: Test each wiring device to verify operation and proper polarity.
D. Correct wiring deficiencies and replace damaged or defective raceways.

3.04 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 PROTECTION
A. Protect installed raceways from subsequent construction operations.

END OF SECTION
SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Wire and cable markers.
D. Voltage markers.
E. Underground warning tape.
F. Floor marking tape.
G. Warning signs and labels.

1.02 RELATED REQUIREMENTS
A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
B. Section 26 05 73 - Power System Studies: Arc flash hazard warning labels.
C. Section 26 23 00 - Low-Voltage Switchgear: Factory-installed mimic bus.
D. Section 26 27 26 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
E. Section 27 10 00 - Structured Cabling: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2015.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
Stantec Architecture Inc.
1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
   B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for each product.
   C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

1.06 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

1.07 FIELD CONDITIONS
   A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS
   A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
   B. Identification for Equipment:
      1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
         a. Switchgear:
            1. Identify ampere rating.
            2. Identify voltage and phase.
            3. Identify power source and circuit number. Include location when not within sight of equipment.
            4. Use identification nameplate to identify main and tie devices.
            5. Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
         b. Switchboards:
            1. Identify ampere rating.
            2. Identify voltage and phase.
3. Identify power source and circuit number. Include location when not within sight of equipment.
4. Use identification nameplate to identify main overcurrent protective device.
5. Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

c. Panelboards:
1. Identify ampere rating.
2. Identify voltage and phase.
3. Identify power source and circuit number. Include location when not within sight of equipment.
4. Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
5. Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
6. For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

d. Transformers:
1. Identify kVA rating.
2. Identify voltage and phase for primary and secondary.
3. Identify power source and circuit number. Include location when not within sight of equipment.
4. Identify load(s) served. Include location when not within sight of equipment.

e. Enclosed switches, circuit breakers, and motor controllers:
1. Identify voltage and phase.
2. Identify power source and circuit number. Include location when not within sight of equipment.
3. Identify load(s) served. Include location when not within sight of equipment.

f. Busway:
1. Identify ampere rating.
2. Identify voltage and phase.
3. Identify power source and circuit number. Include location when not within sight of equipment.
4. Provide identification at maximum intervals of 40 feet.
5. Use identification nameplate to identify load(s) served for each plug-in unit. Include location when not within sight of equipment.

g. Time Switches:
1. Identify load(s) served and associated circuits controlled. Include location.

h. Enclosed Contactors:
1. Identify ampere rating.
2. Identify voltage and phase.
3. Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).

4. Identify coil voltage.

5. Identify load(s) and associated circuits controlled. Include location.

i. Transfer Switches:
   1. Identify voltage and phase.
   2. Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
   3. Identify load(s) served. Include location when not within sight of equipment.
   4. Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

j. Electricity Meters:
   1. Identify load(s) metered.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.
   b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

3. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
   c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.

4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.

5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.

6. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.

7. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

8. Use identification label or identification nameplate on inside of door at each fused switch to identify required NEMA fuse class and size.

9. Use identification label or identification nameplate on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.

10. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
11. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
   a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 91 23 and 09 91 13.
12. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
   a. Service equipment.
   b. Industrial control panels.
   c. Motor control centers.
   d. Elevator control panels.
   e. Industrial machinery.
13. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
   a. Minimum Size: 3.5 by 5 inches.
   b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
   c. Service Equipment: Include the following information in accordance with NFPA 70.
      1. Nominal system voltage.
      3. Clearing time of service overcurrent protective device(s).
      4. Date label applied.
14. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
15. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
16. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
17. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.
3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
   a. At each source and load connection.
   b. Within boxes when more than one circuit is present.
   c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
   d. In cable tray, at maximum intervals of 20 feet.
5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
6. Use underground warning tape to identify direct buried cables.

D. Identification for Cable Tray: Comply with Section 26 05 36.

E. Identification for Boxes:
   1. Use voltage markers to identify highest voltage present.
   2. Use voltage markers or color coded boxes to identify systems other than normal power system.
      a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 and 09 91 13 per the same color code used for raceways.
   3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
      a. For exposed boxes in public areas, use only identification labels.
   4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

F. Identification for Devices:
   1. Identification for Communications Devices: Comply with Section 27 10 00.
   2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
   4. Use identification label to identify fire alarm system devices.
      a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
   5. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
      a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
6. Use identification label or engraved wallplate to identify load controlled for
   wall-mounted control devices controlling loads that are not visible from the
   control location and for multiple wall-mounted control devices installed at one
   location.
7. Use identification label to identify receptacles protected by upstream GFI
   protection, where permitted.

G. Identification for Luminaires:

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Materials:
      a. Indoor Clean, Dry Locations: Use plastic nameplates.
      b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates
         suitable for exterior use.
   3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically
      non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch;
      engraved text.
      a. Exception: Provide minimum thickness of 1/8 inch when any dimension is
         greater than 4 inches.
   4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or
      laser-etched text.
   5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or
      laser-etched text.
   6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up
      to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat,
      and abrasion resistant.
      a. Use only for indoor locations.
   3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten
      text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. System designation where applicable:
1. Emergency Power System: Identify with text "EMERGENCY".
2. Fire Alarm System: Identify with text "FIRE ALARM".
   a. Equipment designation or other approved description.
   b. Other information as indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1 inch.
   b. Equipment Designation: 1/2 inch.
   c. Other Information: 1/4 inch.
   d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
5. Color:
   c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
5. Color: Black text on white background unless otherwise indicated.
   a. Exceptions:
      1. Provide white text on red background for general information or operational instructions for emergency systems.
      2. Provide white text on red background for general information or operational instructions for fire alarm systems.

E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
   a. Include voltage and phase for other than 120 V, single phase circuits.
3. Text: All capitalized unless otherwise indicated.
5. Color: Black text on clear background.

G. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

A. Manufacturers:
   2. HellermannTyton; ______: www.hellermanntyton.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
   1. Do not use handwritten text.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

A. Manufacturers:

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

D. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.

E. Legend:
1. Markers for Voltage Identification: Highest voltage present.
2. Markers for System Identification:
   a. Emergency Power System: Text "EMERGENCY".

F. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

A. Manufacturers:

B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
   1. Exception: Use foil-backed detectable type tape where required by serving utility or where directed by Owner.

C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.

D. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

E. Legend: Type of service, continuously repeated over full length of tape.

F. Color:
   1. Tape for Buried Power Lines: Black text on red background.

2.06 FLOOR MARKING TAPE

A. Manufacturers:

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

2.07 WARNING SIGNS AND LABELS

A. Manufacturers:

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:
1. Materials:
   a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
   b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:
1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   a. Do not use labels designed to be completed using handwritten text.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION
A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover.
   9. Conductors and Cables: Legible from the point of access.
   10. Devices: Outside face of cover.
C. Install identification products centered, level, and parallel with lines of item being identified.
D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
   1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION
SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Short-circuit study.
B. Protective device coordination study.
C. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.
B. Section 26 2100 - Low-Voltage Electrical Service Entrance.
C. Section 26 2416 - Panelboards.
D. Section 26 2813 - Fuses.
E. Section 26 2816.16 - Enclosed Switches.

1.03 REFERENCE STANDARDS

G. NEMA MG 1 - Motors and Generators; 2017.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
   2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Submit study reports prior to or concurrent with product submittals.
   2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
   3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

C. Scheduling:
   1. Arrange access to existing facility for data collection with Owner.
   2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Study preparer's qualifications.

C. Field testing agency's qualifications.

D. Study reports, stamped or sealed and signed by study preparer.

E. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
   1. Include characteristic time-current trip curves for protective devices.
   2. Include impedance data for busway.
   3. Include impedance data for engine generators.
   4. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   5. Include documentation of listed series ratings upon request.
   6. Identify modifications made in accordance with studies that:
      a. Can be made at no additional cost to Owner.
      b. As submitted will involve a change to the contract sum.

F. Field quality control reports.

G. Certification that field adjustable protective devices have been set in accordance with requirements of studies.
H. Project Record Documents: Revise studies as required to reflect as-built conditions.
   1. Include hard copies with operation and maintenance data submittals.
   2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.06 POWER SYSTEM STUDIES

A. Scope of Studies:
   1. Perform analysis of new electrical distribution system as indicated on drawings.
   2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
   3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
      a. Known Operating Modes:
         1) Utility as source.
         2) Generator as source.
         3) Utility/generator in parallel.
         4) Bus tie breaker open/close positions.
         5) Maintenance settings.

B. General Study Requirements:
   1. Comply with NFPA 70.
   2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
         1) Obtain up-to-date information from Utility Company.
         2) Utility Company: As indicated on drawings.
      b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
      c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
      d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
      e. Protective Devices:
         1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).

f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.

g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:
2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
   a. Maximum utility fault currents.
   b. Maximum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Study Reports:
1. General Requirements:
   a. Identify date of study and study preparer.
   b. Identify study methodology and software product(s) used.
   c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
   d. Identify base used for per unit values.
   e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
   f. Include conclusions and recommendations.
2. Short-Circuit Study:
   a. For each scenario, identify at each bus location:
      1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
      2) Fault point X/R ratio.
      3) Associated equipment short circuit current ratings.
   b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
3. Protective Device Coordination Study:
   a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
   b. For each graph include (where applicable):
      1) Partial single-line diagram identifying the portion of the system illustrated.
      2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
      3) Conductors: Damage curves.
      4) Transformers: Inrush points and damage curves.
      5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
      6) Motors: Full load current, starting curves, and damage curves.
      7) Capacitors: Full load current and damage curves.
   c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
      1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
      2) Include ground fault pickup and delay.
      3) Include fuse ratings.
      4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
   d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

1.07 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in the preparation of studies of similar type and complexity using specified computer software.
   1. Study preparer may be employed by the manufacturer of the electrical distribution equipment.
   2. Study preparer may be employed by field testing agency.

B. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.
   1. Field Supervisor: Certified electrical testing technician; NETA ETT Level III.

   1. Acceptable Software Products:
PART 2 PRODUCTS

PART 3 EXECUTION

3.01 INSTALLATION

3.02 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.
C. Inspect and test in accordance with NETA ATS, except Section 4.
D. Adjust equipment and protective devices for compliance with studies and recommended settings.
E. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.
F. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.03 CLOSEOUT ACTIVITIES
A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

END OF SECTION
SECTION 26 05 83 - WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS
   A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   B. Section 26 05 33.13 - Conduit for Electrical Systems.
   C. Section 26 05 33.16 - Boxes for Electrical Systems.
   D. Section 26 27 26 - Wiring Devices.
   E. Section 26 28 16.16 - Enclosed Switches.
   F. Section 26 29 13 - Enclosed Controllers.

1.03 REFERENCE STANDARDS
   A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R2015).
   B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.
   C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
      2. Determine connection locations and requirements.
   B. Sequencing:
      1. Install rough-in of electrical connections before installation of equipment is required.
      2. Make electrical connections before required start-up of equipment.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.
C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

B. Disconnect Switches: As specified in Section 26 28 16.16 and in individual equipment sections.

C. Wiring Devices: As specified in Section 26 27 26.

D. Flexible Conduit: As specified in Section 26 05 33.13.

E. Wire and Cable: As specified in Section 26 05 19.

F. Boxes: As specified in Section 26 05 33.16.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION
SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Design Phase Commissioning Manual applies to this section.

C. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

D. Division 1 Section 01 91 13 - General Commissioning Requirements

E. Division 26 Section 26 08 11:- Commissioning of Lighting and Lighting Controls Systems

1.02 SUMMARY

A. The purpose of this Section is to define Contractor responsibilities in the commissioning process, which are being directed by the Contractor. Other electrical system testing is required under other Division 26 Specification Sections. National Electrical Installation Standards (NEIS) NECA 90-2004, “Recommended Practice for Commissioning Building Electrical Systems”, 27th Volume of the NEIS Series, provides additional guidance for the commissioning of electrical systems.

B. Commissioning requires the participation of the Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. General Commissioning requirements and coordination are detailed in Division 01. Division 26 shall be familiar with all parts of Division 01 and the Commissioning Plan issued by the Contractor and shall execute all Commissioning responsibilities assigned to them in the Contract Documents and include the cost of Commissioning in the Contract price.

C. Electrical systems to be commissioned include the following:
   1. Refer to list of commissioned equipment and systems in Section 01 91 13 - General Commissioning Requirements
   2. Lighting Fixtures and Controls (Refer to Section 26 08 11 - Commissioning of Lighting and Lighting Controls Systems)

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
C. All materials, installation and workmanship shall comply with the applicable requirements and standards.

1.04 SUBMITTALS

A. Contractor shall prepare Prefunctional Checklists and Functional Performance Test (FPT) procedures and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Owner for review and approval.

B. Contractor shall provide Owner with documentation required for Commissioning work. At minimum, documentation shall include: Detailed Start-up procedures, Full sequences of operation, Operating and Maintenance data, Performance data, Functional Performance Test Procedures, Control Drawings, and details of Owner-Contracted tests.

C. Contractor shall submit to Owner installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.

D. Contractor shall review and approve other relative documentation for impact on FPT’s of the systems:
   1. Shop Drawings and product submittal data related to systems or equipment to be commissioned. The Subcontractor responsible for the FPT shall review and incorporate comments from the Owner and AE via the Contractor.
   2. Incorporate manufacturer’s Start-up procedures with Prefunctional checklists.
   3. Draft Electrical Testing Agency (ETA) Reports: Review and provide comments to Owner.
   4. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT’s.
   5. Completed equipment Start-up certification forms along with the manufacturer’s field or factory performance and Start-up test documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT’s.
   6. Final ETA Reports: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT’s.
   7. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.
PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 TEST EQUIPMENT

A. Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.

B. All specialized tools, test equipment, and instruments required to execute Start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Calibration shall be NIST traceable. Contractor must calibrate test equipment and instruments according to manufacturer’s recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

C. Infrared Thermographic Scanner:

PART 3 - EXECUTION

3.01 PREPARATION

A. Construction Phase:
1. In each purchase order or subcontract that is written for changes in scope, include the following requirements for submittal data, Commissioning documentation, testing assistance, Operating and Maintenance (O&M) data, and training, as a minimum.
2. Attend Pre-Commissioning Meeting(s), Pre-Installation Meeting(s), and other Project meetings scheduled by the Contractor to facilitate the Commissioning process.
3. Provide manufacturer’s data sheets and shop drawing submittals of equipment.
4. Provide additional requested documentation to the Contractor, prior to O&M manual submittals, for development of Prefunctional Checklist and Functional Performance Tests procedures.
   a. Typically, this will include detailed manufacturer’s installation and Start-up, operating, troubleshooting and maintenance procedures, full details of any Owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.
   b. In addition, the installation, Start-up, and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet
forms to be used by the factory or field technicians shall be submitted to
the Contractor.

5. With input from the BMS Provider and AE, Clarify the operation and control of
commissioned equipment in areas where the Specifications, EMCS control
drawings, or equipment documentation are not sufficient for writing detailed test
procedures.

6. Prepare the specific Functional Performance Test procedures specified. Ensure
that Functional Performance Test procedures address feasibility, safety, and
equipment protection and provide necessary written alarm limits to be used
during the tests.

7. Develop the Commissioning Plan using manufacturer’s Start-up procedures and
the Prefunctional Checklists. Submit manufacturer’s detailed Start-up
procedures and the Commissioning Plan and procedures and other requested
equipment documentation to Owner for review.

8. During the Start-up and initial checkout process, execute and document related
portions of the Prefunctional Checklists for all commissioned equipment.

9. Perform and clearly document all completed Prefunctional Checklists and
Start-up procedures. Provide a copy to the Owner prior to the Functional
Performance Test.

10. Address current AE and Owner punch list items before Functional Performance
Tests. Air and water test, adjust and balance shall be completed with
discrepancies and problems remedied before Functional Performance Tests of
the respective air or water related systems are executed.

11. Provide skilled technicians to execute starting of equipment and to assist in
execution of Functional Performance Tests. Ensure that they are available and
present during the agreed-upon schedules and for a sufficient duration to
complete the necessary tests, adjustments, and problem solving.

12. Correct deficiencies (differences between specified and observed performance)
as interpreted by the Owner’s Project Manager and AE and retest the system
and equipment.

13. Compile all Commissioning records and documentation to be included in a
Commissioning and Closeout Manual.

14. Prepare O&M manuals according to the Contract Documents, including clarifying
and updating the original sequences of operation to as-built conditions.

15. During construction, maintain as-built marked-up Drawings and Specifications of
all Contract Documents and Contractor-generated coordination Drawings.
Update after completion of Commissioning activities (include deferred tests).
The as-built drawings and specifications shall be delivered to the Owner both in
electronic format and hard copies as required by the Owner.

16. Provide training of the Owner’s operating personnel as specified.

17. Coordinate with equipment manufacturers to determine specific requirements to
maintain the validity of the warranty.

B. Warranty Phase:

1. Execute seasonal or deferred tests, witnessed by the Owner, according to the
Specifications.
   a. Complete deferred tests as part of this Contract during the Warranty
      Period. Schedule this activity with Owner. Perform tests and document
and correct deficiencies. Owner may observe the tests and review and approve test documentation and deficiency corrections.

b. If any check or test cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, execution of such test may be delayed to later in the Warranty Period, upon approval of the Owner. Contractor shall reschedule and conduct these unforeseen deferred tests in the same manner as deferred tests.

c. Correct deficiencies and make necessary adjustments to O&M manuals, Commissioning documentation, and as-built drawings for applicable issues identified in any seasonal testing.

C. Electrical Testing Agency (ETA)

1. In general, testing of systems, including NETA testing, is the responsibility of the contractor as specified in division 26, 27, and 28 specifications. When requested by Owner, the Contractor shall retain an independent Electrical Testing Agency (ETA). Their specific testing responsibilities are delineated in Section 26 01 00 - Basic Electrical Requirements. This generally requires checking and testing of the electrical power distribution equipment per National Electrical Testing Association (NETA).

2. Attend Pre-Commissioning Meeting(s), Pre-Installation Meeting(s), and other Project meetings scheduled by the Contractor to facilitate the Commissioning process.

3. Obtain all required manufacturer's data to facilitate tests.

4. Provide assistance to the Contractor in preparation of the specific Prefunctional Checklist and Functional Performance Test procedures specified. Generally ETA shall provide their standard forms to document the NETA tests to be incorporated into the Prefunctional Checklist and Functional Performance Tests record.

5. During related tests, execute and document the tests in the approved forms and/or test record.

6. Perform and clearly document all completed Start-up and system operational checkout procedures, providing a copy to the Contractor.

7. Clearly indicate any deficiencies identified during testing and add to an action list for resolution and tracking. The field technicians shall keep a running log of events and issues. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, Contract interpretation requests and lists of completed tests to the Contractor at least twice a week and provide technical assistance in the resolution of deficiencies.

8. Provide skilled technicians to execute testing. Ensure that they are available and present during the agreed-upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

9. Warranty Phase: Perform thermographic imaging of loaded panel at time designated by Electrical SubContractor or Contractor.
3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

3.03 TESTING

A. Prefunctional Checklists and Start-up:
   1. Follow the Start-up and initial checkout procedures listed in this Section and in Division 01. Start-up and complete systems and sub-systems so they are fully functional, meeting the requirements of the Contract Documents.
   2. Prefunctional Checklists shall be complete prior to commencement of a Functional Performance test.
   3. Refer to the “Design Phase Commissioning Manual” for specific details on required Prefunctional Checklists.

B. Functional Performance Tests:
   1. Functional Performance Tests are conducted after system Start-up and checkout is satisfactorily completed.
   2. Refer to the “Design Phase Commissioning Manual” for specific details on the required Functional Performance Tests.

C. Coordination Between Testing Parties:
   1. Factory Start-ups: Factory Start-ups are specified for certain equipment. Factory Start-ups generally are Start-up related activities that will be reviewed and checked prior to Functional Performance Tests. All costs associated with factory Start-ups shall be included with the contract price unless otherwise noted. Notify the Commissioning Team of the factory Start-up schedule and coordinate these factory Start-ups with witnessing parties. The Commissioning Team members may witness these Start-ups at their discretion.
   2. Independent Testing Agencies: For systems that specify testing by an independent testing agency, the cost of the test shall be included in the Contract price unless otherwise noted. Testing performed by independent agencies may cover aspects required in the Prefunctional Checklists, Start-ups, and Functional Performance Tests. Coordinate with the independent testing agency so that Owner and/or AE can witness the test to ensure that applicable aspects of the test meet requirements.

3.04 TRAINING

A. Submit a written training plan to the Owner and Architect/Engineer for review and approval. Contractor’s training plan shall cover the following elements:
   1. Equipment included in training.
   2. Intended audience.
   3. Location of training.
4. Objectives.
5. Subjects covered.
6. Duration of training on each subject.
7. Instructor for each subject.
8. Methods (classroom lecture, video, Site walk-through, actual operational demonstrations, written handouts, etc.).
9. Instructors and qualifications.

B. Contractor shall have the following training responsibilities:
1. Provide a training plan ten (10) calendar days prior to the scheduled training, in accordance with Division 01.
2. Provide Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
3. Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including Start-up, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This representative may be the Start-up technician for the piece of equipment, the installing contractor, or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The training sessions shall follow the outline in the Table of Contents of the O&M manual and illustrate whenever possible the use of the O&M manuals for reference.
7. Training shall include:
   a. Usage of the printed installation, operation and maintenance instruction material included in the O&M manuals.
   b. Review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include Start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
   c. Discussion of relevant health and safety issues and concerns.
   d. Discussion of warranties and guarantees.
   e. Common troubleshooting problems and solutions.
   f. Explanation of information included in the O&M manuals and the location of all plans and manuals in the facility.
   g. Discussion of any peculiarities of equipment installation or operation.
8. Hands-on training shall include Start-up, operation in all modes possible, including manual, shutdown, and any emergency procedures and maintenance of all pieces of equipment.
9. Training shall occur after Functional Performance Tests are complete and shall be scheduled with the Owner’s Project Manager.
10. Contract shall coordinate training schedule with building owner for each piece of equipment.

END OF SECTION
SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Standalone daylight-harvesting dimming controls.
   2. Indoor occupancy and vacancy sensors.
   4. High-bay occupancy sensors.
   5. Emergency shunt relays.
   6. Conductors and cables.

B. Related Requirements:
   1. Section 26 27 26 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show installation details for the following:
      a. Occupancy sensors.
      b. Vacancy sensors.
   2. Interconnection diagrams showing field-installed wiring.
   3. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
2. Structural members to which equipment will be attached.
3. Items penetrating finished ceiling, including the following:
   a. Luminaires.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Control modules.

1.05 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.06 WARRANTY
A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of lighting control software.
      b. Faulty operation of lighting control devices.
   2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 DAYLIGHT-HARVESTING DIMMING CONTROLS
A. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated or separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
   3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

D. Power Pack: Dry contacts rated for 20-A load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
   1. LED status lights to indicate load status.
   2. Plenum rated.

E. Power Pack: Digital controller capable of accepting 3 RJ45 inputs with one output rated for LED load at 120- and 277-V ac, for 16-A at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
   1. With integral current monitoring
      a. Compatible with digital addressable lighting interface.
      1) Plenum rated.

2.02 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:
   2. Dual technology.
   3. Integrated or separate power pack.
   4. Hardwired connection to switch; and BAS and lighting control system.
   5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   6. Operation:
      a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
      b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Sensor is powered from the power pack.
9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

2.03 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS using hardwired connection.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.

2.04 HIGH-BAY OCCUPANCY SENSORS

A. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.

3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.


5. Operating Ambient Conditions: 32 to 149 deg F.


7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

8. Detector Technology: PIR.

9. Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor.

B. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

C. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.05 EMERGENCY SHUNT RELAY

A. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 or 277 V.

2.06 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
PART 3 - EXECUTION

3.01 EXAMINATION
   A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
   B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SENSOR INSTALLATION
   A. Comply with NECA 1.
   B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
   C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer’s written instructions.

3.03 WIRING INSTALLATION
   A. Comply with NECA 1.
   B. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
   C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer’s written instructions.
   D. Size conductors according to lighting control device manufacturer’s written instructions unless otherwise indicated.
   E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.04 IDENTIFICATION
   A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."
1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.06 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
   2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
   3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.07 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.08 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 26 09 43.16 "Addressable-Luminaire Lighting Controls" and Section 26 09 43.23 "Relay-Based Lighting Controls."

3.09 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes:

1. Individually addressable lighting control devices communicating with data-entry and -retrieval devices using Network protocol.

B. Related Sections:

1. Section 26 09 23 "Lighting Control Devices" for time clocks, photoelectric sensors, occupancy sensors, and multipole contactors.

1.03 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. BAS: Building automation system.

C. DALI: Digital addressable lighting interface.

D. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

F. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

G. PC: Personal computer; sometimes plural as "PCs."

H. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

I. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.
J. UTP: Unshielded twisted pair.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, network materials, manual switches and plates, and conductors and cables.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

1.06 CLOSEOUT SUBMITTALS

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

1.07 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.

E. Comply with NFPA 70.

1.08 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of lighting control functions.
   2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
   3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

B. Coordinate lighting control components specified in this Section with components specified in Section 26 24 16 "Panelboards."

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of software input/output to execute switching or dimming commands.
      b. Failure of modular relays to operate under manual or software commands.
      c. Damage of electronic components due to transient voltage surges.
   2. Warranty Period: Two years from date of Substantial Completion.
   3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
   4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.
PART 2 - PRODUCTS

2.01 NETWORKED, INDIVIDUALLY ADDRESSABLE LIGHTING CONTROLS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product for review and approval.

B. System Requirements:

1. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

2. Performance Requirements: Individually addressable devices (such as dimmers, and manual switches) are operated from digital signals received through a bus, from data-entry and -retrieval devices (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hub.

3. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.

   a. Hardwired Points:

      1) Monitoring: On-off status.
      2) Control: On-off operation.

   b. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

C. Control Module:

1. Control Module Description: Programmable, PC-based unit with 15-inch color LCD and keyboard for graphic display and programming of system status and to override breaker status; and to display status of local override controls and diagnostic information. If the control module is applied to emergency lighting units, control unit shall indicate failure of normal power and that the lighting units are, or are not, powered by the alternate power source.


   b. Display: Separate graphic displays for programming each lighting control panelboard.

   c. Interoperability: Control module shall be configured to connect to BACnet-compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.
d. Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with network-compliant, digital-communication devices. Software shall be written for Windows operating system, with the full suite of network commands and device parameter settings.

e. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration. Network compliant.

f. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes. Network compliant.

g. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling. Network compliant.

h. Astronomic Control: Automatic adjustment of dawn and dusk switching. Network compliant.

i. Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.

j. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.

1) Software shall interpret status signals, provide for their display, and initiate failure signals.

2) Lamp or LED at control module or display panel shall identify status of each controlled circuit.

k. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over data links. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.

l. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed. Network compliant.

m. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override. Network compliant.

n. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off. Network compliant.

o. Programmed time signals shall change preset scenes and dimmer settings.
p. Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming fluorescent ballast control circuits. Signal shall control dimming of fixture so illumination level remains constant as daylight contribution varies.

q. Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.

r. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

s. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

t. Additional Programming: In addition to system programming by the PC, individual control modules shall be networked and programmable using data-entry and -retrieval (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs.

D. Network Materials:


   a. Network-Compliant Network Power Rating: One full-rated network for powering up to 64 addressable devices for each network; suitable for use with NFPA 70, Class 1 and Class 2 control circuits; and 16 V dc, 250 mA.

   b. Primary Power: 120 or 277 V, field selectable; 12 VA.

   c. 10basT Ethernet port.

   d. LED indicator lights for Ethernet status (link, send, and receive), power-on, and network failure.

2. Lighting Control Software:

   a. Five-tier hierarchical architecture; high-speed, parallel query; and distributed-logic processing scalable from single rooms to full campuses.

   b. Automatic backup for all settings and parameters.

   c. TCP/IP network protocol.

   d. Interactive with other building management systems at TCP/IP level.

   e. At least three security levels.

   f. Support the full suite of network commands and device parameter settings.

   g. Scheduling modules to provide building-wide scene scheduling.

   h. Billing modules to track energy use for multiple tenants and able to produce monthly billing statements.

   i. Support load shedding, peak shaving, sweeps with local override, and other energy-conservation measures.
j. Able to report individual device status, including inoperative lamps, ballast failure detection, and dimmer position.

2.02 MANUAL ANALOG SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
   1. Match color specified in Section 26 27 26 "Wiring Devices."
   2. Integral green LED pilot light to indicate when circuit is on.
   3. Internal white LED locator light to illuminate when circuit is off.

B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 26 27 26 "Wiring Devices."

C. Wall-Box Dimmers: Comply with Section 26 27 26 "Wiring Devices."

D. Wall Plates: Single and multigang plates as specified in Section 26 27 26 "Wiring Devices."

E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.03 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

A. Connection Type: RS-485 protocol, category 5e UTP cable, using RJ45 connectors. Power shall be from the control unit.

B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
   1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Section 26 27 26 "Wiring Devices."
   2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.04 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
D. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Section 27 15 00 "Communications Horizontal Cabling."

E. RS-485 Cables:

1. Standard Cable: NFPA 70, Type CM.
   a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1581.

2. Plenum-Rated Cable: NFPA 70, Type CMP.
   a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
   b. Fluorinated ethylene propylene insulation.
   c. Unshielded.
   d. Fluorinated ethylene propylene jacket.
   e. Flame Resistance: NFPA 262, Flame Test.

**PART 3 - EXECUTION**

3.01 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways. Minimum conduit size shall be 1/2 inch.

1. For power wiring comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Section 26 05 23 "Control-Voltage Electrical Power Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

G. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Assist factory-authorized service representative in performing tests and inspections.

C. Tests and Inspections:
   1. Test for circuit continuity.
   2. Verify that the control module features are operational.
   3. Check operation of local override controls.
   4. Test system diagnostics by simulating improper operation of several components selected by Architect.

D. Lighting controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.03 SOFTWARE INSTALLATION

A. For the following systems install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

   1. Manually operated PC-based digital controls.
   2. Network networked individually addressable controls.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 DEMONSTRATION AND TRAINING

A. Demonstrate to Owner's personnel operation of lighting controls. See Section 01 79 00 "Demonstration and Training."
B. For the following systems train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. See Section 01 79 00 "Demonstration and Training."

1. Manually operated PC-based digital controls.
2. Networked addressable controls.

END OF SECTION 26 09 43
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes control sequences for lighting systems, subsystems, and equipment.

B. System Overview:

1. The main lighting control system shall be a digitally distributed system consisting of relays provided through associated control devices with local over-ride control stations, astronomical time clock, occupancy sensor, and photo sensor interfaces.

2. Refer to the Electrical and Architectural Lighting Drawings for additional information regarding specific specifications and locations of equipment and devices.

C. Related Requirements:

1. Section 26 09 23 "Lighting Control Devices" for time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

2. Section 26 09 43 "Network Lighting Controls."

PART 2 - PRODUCTS

2.01 OPERATION

A. Operational Intent for Daylighting Control of Lighting Loads.

1. Dimmable Daylight Control:

   a. Daylight harvesting shall be implemented for daylight penetration areas using continuous dimming controlled by daylight sensors.

   b. Dimming devices shall be 0-10V, 4 wire low voltage controlled by a focusable 0-10V current daylight sensor.

   c. Each daylight zone shall have a separate photocell or an interface device providing local 0-10V control signal to the dimming devices.
d. The photocell zones shall be programmed to provide shutoff of these luminaires when there is enough daylight to negate the need for the electric illumination to be on at the minimum output.
e. Luminaires may have a different switching zone (ON/OFF/DIM) than the daylight zone. Daylight zones may cross switching zones.

B. Sequence of Operation:

1. Refer to the Architectural Lighting Control Drawings EA500 series for detailed sequence of controls by space type.
2. The following is a generic list of control types detailing the functionality and user interface:
   a. On/Off/Dimming Manual Control: On/Off switching is provided for local manual over-ride to turn lights ON and OFF as needed. Press and hold dimming function can be enabled by programming as indicated for specific space types.
   b. On/Off Occupancy Sensor Control: Low-voltage wall mounted switch box occupancy sensors programmed for automatic ON and automatic 10-minute time delay OFF shall provide automated control while allowing manual override at the switch on the occupancy sensor device.
   c. Time Clock Control: The lighting shall be programmed to automatically switch ON based on a schedule of when the facility is open for business and shall correspondingly be programmed to sweep the lights OFF when the facility closes for business.

1) All OFF sweeps shall be preceded by a flash warning when the lights are ON.
2) An initial schedule for programming automatic time clock functions can be found in the EA500 series Drawings.
3) All time clock schedules for automatic ON/OFF programming shall be coordinated with the Owner prior to final commissioning.

d. Daylight Harvesting Dimming: Continuous closed loop dimming of the lights via local 0-10V daylight sensor and interface control devices.

1) This function is independent of the ON/OFF function and will only function IF the light is switched ON via the relay in the associated switch or power pack controlling device. When the power pack switches the power ON the light will illuminate to the level allowed by the associated daylight sensor and its settings.
2) The daylight zoning of the lights may be different than the switch zoning referred to in the preceding paragraph titled "Operational Intent for Daylighting Control of Lighting Loads." The daylight zoning is defined by the daylight penetration into the building. Lights with similar daylight penetration will be zoned together to minimize daylight sensor deployment regardless of switching zone.
3) The sensor settings shall be programmed via the control system software.
e. Daylight Harvesting On/Off Control: On/Off control of luminaires is achieved via local closed loop daylight sensor with associated set-points of control. Due to the prevalence of relatively high level and uniform daylight penetration into areas of the building, there is a second layer of daylight harvesting to turn the lights off when such sufficient levels of daylight illumination are present. Essentially, this will prevent the luminaires from remaining on for extended durations, at their fully dimmed level, by automatically shutting the luminaires off. Once the daylight levels diminish later in the day (if the switch control is still ON), the luminaires will be turned back on (to their dimmed state as determined by the local 0-10V daylight sensor).

1) Set-points for the associated readings from the daylight sensor shall be programmed during commissioning and should only need to be programmed once. Any future adjustments will need to be made via the system software.

f. Night Lights: Luminaires indicated as Night Lights (NL) shall be programmed to fully function with the daylight harvesting and dimming zones during daylight hours and shall remain on during all hours of darkness to provide minimal levels of illumination for access and security.

g. Exterior - Building Mounted Lighting:

1) Exterior building lighting shall be controlled by the digital lighting control system utilized for the interior lighting.

2) Exterior ambient north facing photo sensor and astronomical time clock functions shall be programmed to turn the lights ON by photocell and OFF by either photocell or time clock as determined by the Owner based on the control zones and the after-hours security needs.

h. Exterior - Site Lighting:

1) Exterior site lighting (not mounted to the building or any structure attached to the building) shall be controlled by the digital lighting control system.

   a) Exterior ambient photo sensor and astronomical time clock functions programmed to turn the lights ON by photocell and OFF by either photocell or time clock as determined by the Owner based on the control zones and the after-hours security needs.

i. After-Hours and Building Security:

1) The lighting system is designed to go "black" at night with exception of the exterior building lighting and interior lights located at points of access where security cameras need illumination and people need basic lighting for safety and way finding.
2) Building Security Sweeps:

a) As a person comes to the building after-hours there is exterior lighting at the main entry and points of access for security.

b) The lights located in the vestibule area shall be un-switched night lights that remain on during the night and after-hours.

END OF SECTION 26 09 93
SECTION 26 21 00 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical service requirements.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Materials and installation requirements for cast-in-place concrete equipment pads.

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

D. Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Section 26 05 33.13 - Conduit for Electrical Systems.

F. Section 26 05 33.23 - Surface Raceways for Electrical Systems: Wireways.

G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

H. Section 26 23 00 - Low-Voltage Switchgear: Service entrance equipment.
   1. Includes utility metering transformer compartment.
   2. Includes non-utility electrical metering.

I. Section 26 24 13 - Switchboards: Service entrance equipment.
   1. Includes utility metering transformer compartment.
   2. Includes non-utility electrical metering.

J. Section 26 24 16 - Panelboards: Service entrance equipment.

K. Section 26 28 16.16 - Enclosed Switches: Service entrance equipment.

L. Section 31 23 16 - Excavation.


N. Section 31 23 23 - Fill: Bedding and backfilling.

1.03 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.04 REFERENCE STANDARDS

1.05 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.

B. Coordination:
   1. Verify the following with Utility Company representative:
      a. Utility Company requirements, including division of responsibility.
      b. Exact location and details of utility point of connection.
      c. Utility easement requirements.
      d. Utility Company charges associated with providing service.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
   3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with other installers to provide communication lines required for Utility Company meters.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.
   1. Submit Service application as required by Utility Company.
   2. Submit Exception applications for any deviations from Utility requirements to Utility prior to installation. Obtain written approval letter for Exceptions from Utility Company prior to installation.

D. Utility Company charges associated with providing permanent service to be paid by Owner.

E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

F. Scheduling:
   1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
   2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.06 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Utility Company letter of availability for providing electrical service to project.
C. **Product Data**: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.

D. **Shop Drawings**: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.
   1. Obtain Utility company approval of shop drawings prior to submittal.

E. Drawings prepared by Utility Company.

F. **Project Record Documents**: Record actual locations of equipment and installed service routing.

### 1.07 QUALITY ASSURANCE

A. Comply with the following:
   2. NFPA 70 (National Electrical Code).
   3. The requirements of the Utility Company.
   4. The requirements of the local authorities having jurisdiction.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. **Products**: Listed, classified, and labeled as suitable for the purpose intended.

D. **Product Listing Organization Qualifications**: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### 1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer’s instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.
PART 2 PRODUCTS

2.01 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics: As indicated on drawings.

C. Utility Company: As indicated on drawings.

D. Division of Responsibility:
   1. Pad-Mounted Utility Transformers:
      a. Transformer Vaults and Pads: Furnished and installed by Contractor per Utility Company requirements.
      b. Transformers: Furnished and installed by Utility Company.
      d. Transformer Protective Bollards: Furnished and installed by Contractor per Utility Company requirements.
      e. Primary:
         1. Trenching and Backfilling: Provided by Contractor.
         2. Conduits: Furnished and installed by Contractor.
      f. Secondary:
         1. Trenching and Backfilling: Provided by Contractor.
         2. Conduits: Furnished and installed by Contractor.
         3. Conductors: Furnished and installed by Contractor (Service Point at transformer).
   2. Pole-Mounted Utility Transformers:
      b. Transformers: Furnished and installed by Utility Company.
      d. Primary: Furnished and installed by Utility Company.
      e. Secondary - Underground Service:
         2. Conductors: Furnished and installed by Contractor (Service Point at utility pole).
      f. Secondary - Overhead Service:
         2. Conductors: Furnished and installed by Contractor (Service Point at service mast).
   3. Terminations at Service Point: Provided by Utility Company.
   4. Metering Provisions:
a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.
b. Metering Transformer Cabinets: Furnished and installed by Contractor per Utility Company requirements.
d. Metering Transformers: Furnished and installed by Utility Company.
e. Conduits Between Metering Transformers and Meters: Furnished and installed by Contractor per Utility Company requirements.
f. Wiring Between Metering Transformers and Meters: Furnished and installed by Utility Company.
g. Communications Conduits for Meters: Furnished and installed by Contractor per Utility Company requirements.

5. Service Connection Cabinets: Furnished and installed by Contractor per Utility Company requirements.
   a. Cable trough: Furnish and installed by Contractor per Utility Company requirements between transformer and Service Connection Cabinet.

   E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.
   C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
   A. Verify and mark locations of existing underground utilities.

3.03 INSTALLATION
   A. Install products in accordance with manufacturer’s instructions and Utility Company requirements.
   B. Perform work in accordance with NECA 1 (general workmanship).
   C. Arrange equipment to provide minimum clearances and required maintenance access.
   D. Provide required trenching and backfilling in accordance with Section 31 23 16.13.
   E. Construct cast-in-place concrete pads for utility equipment in accordance with Utility Company requirements and Section 03 30 00.
F. Provide required protective bollards in accordance with Utility Company requirements.

G. Provide required support and attachment components in accordance with Section 26 05 29.

H. Provide grounding and bonding for service entrance equipment in accordance with Section 26 05 26.

I. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 05 53.

3.04 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION
SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. General purpose transformers.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
D. Section 26 05 33.13 - Conduit for Electrical Systems: Flexible conduit connections.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 24 16 - Panelboards.

1.03 REFERENCE STANDARDS
B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.
C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.
F. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
   1. Vibration Isolators: Include attachment method and rated load and deflection.
C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
D. Project Record Documents: Record actual locations of transformers.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. 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.
B. 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.

1.08 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
   1. Greater than 10 kVA: 104 degrees F maximum.
   2. Less than 10 kVA: 77 degrees F maximum.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation; ______: www.eaton.com/#sle.
B. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
C. Siemens Industry, Inc; ______: www.usa.siemens.com/#sle.
D. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
   1. Altitude: Less than 3,300 feet.
   2. Ambient Temperature:
      a. Greater than 10 kVA: Not exceeding 104 degrees F.
      b. Less than 10 kVA: Not exceeding 77 degrees F.

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Primary Voltage: 480 volts delta, 3 phase.

C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
   2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

E. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

F. Winding Taps:
   1. Less than 3 kVA: None.
   2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
   3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
   4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

H. Sound Levels: Standard sound levels complying with NEMA ST 20.

I. Mounting Provisions:
   1. Less than 15 kVA: Suitable for wall mounting.
   2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
   3. Larger than 75 kVA: Suitable for floor mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 2.
      b. Outdoor locations: Type 3R.
   2. Construction: Steel.
      a. Less than 15 kVA: Totally enclosed, non-ventilated.
b. 15 kVA and Larger: Ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

K. Accessories:
1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Install transformers in accordance with NECA 409 and IEEE C57.94.
D. Use flexible conduit, under the provisions of Section 26 05 33.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
F. Install transformers plumb and level.
G. Transformer Support:
1. Provide required support and attachment in accordance with Section 26 05 29, where not furnished by transformer manufacturer.
2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
H. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

I. Mount floor-mounted transformers on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.

J. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.

K. Mount trapeze-mounted transformers as indicated.

L. Provide seismic restraints.

M. Provide grounding and bonding in accordance with Section 26 05 26.

N. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

O. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

P. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.

Q. Identify transformers in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.
   1. 167 kVA single phase, 500 kVA three phase and smaller:
      a. Perform turns ratio tests at all tap positions.
   2. Larger than 167 kVA single phase and 500 kVA three phase:
      a. Verify that control and alarm settings on temperature indicators are as specified.
      b. Perform excitation-current tests on each phase.
      c. Measure the resistance of each winding at each tap connection.
      d. Perform an applied voltage test on all high- and low-voltage windings-to-ground.

3.04 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust primary taps so that secondary voltage is within two percent of rated voltage.

C. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
3.05 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Power distribution panelboards.
B. Lighting and appliance panelboards.
C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
E. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
F. Section 26 22 00 - Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.
G. Section 26 28 13 - Fuses: Fuses for fusible switches and spare fuse cabinets.
H. Section 26 43 00 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Revision E with Supplement 1, 2013.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
F. NEMA PB 1 - Panelboards; 2011.
G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 67 - Panelboards; Current Edition, Including All Revisions.

K. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.


1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
   4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
   3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   4. Include documentation of listed series ratings upon request.

D. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

G. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Panelboard Keys: Two of each different key.
3. See Section 26 28 13 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
2. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE; ______: www.geindustrial.com/#sle.

B. Eaton Corporation; ______: www.eaton.com/#sle.

C. Schneider Electric; Square D Products; ______: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc; ______: www.usa.siemens.com/#sle.

E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Nameplate information shall include catalog number or factory order number, date of manufacturing, UL Listed label, ampere, voltage, phase, and AIC ratings.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
      b. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

D. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
   2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
   3. Label equipment utilizing series ratings as required by NFPA 70.

E. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

F. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

G. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

H. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide 200 percent rated neutral bus and lugs where indicated, where oversized neutral conductors are provided, or where panelboards are fed from K-rated transformers.
3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
      b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
      c. Provide removable end walls for NEMA Type 1 enclosures.
      d. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.

3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
   c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

K. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

L. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list and label panelboards as a complete assembly including surge protective device.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
   2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
      a. Use zero sequence ground fault detection method unless otherwise indicated.
      b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
N. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

O. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

P. Load centers are not acceptable.

Q. Provide the following features and accessories where indicated or where required to complete installation:
   1. Feed-through lugs.
   2. Sub-feed lugs.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
   1. Phase and Neutral Bus Material: Aluminum or copper.
   2. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers:
   1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
   2. Provide thermal magnetic circuit breakers unless otherwise indicated.
   3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
   1. Provide surface-mounted enclosures unless otherwise indicated.
   2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.
   3. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
   4. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
   2. Phase and Neutral Bus Material: Aluminum or copper.
   3. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
   1. Provide surface-mounted or flush-mounted enclosures as indicated.
   2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
   3. Provide clear plastic circuit directory holder mounted on inside of door.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Fusible Switches:
   1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
   2. Fuse Clips: As required to accept indicated fuses.
      a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
   3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
   4. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

B. Molded Case Circuit Breakers:
   1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   2. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
         1. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
         2. 14,000 rms symmetrical amperes at 480 VAC.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
      c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   b. Provide interchangeable trip units where indicated.

5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   a. Provide the following field-adjustable trip response settings:
      1. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      2. Long time delay.
      3. Short time pickup and delay.
      4. Instantaneous pickup.
      5. Ground fault pickup and delay where ground fault protection is indicated.


7. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
   d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
   e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

9. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.

10. Do not use tandem circuit breakers.

11. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

12. Provide the following features and accessories where indicated or where required to complete installation:
    a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
    b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

13. Dwelling Units:
a. **Arc-Fault Circuit-Interrupter Protection.** Arc-fault circuit-interrupter protection shall be provided as required in NEC 210.12(A), (B), and (C). The arc-fault circuit interrupter shall be installed in a readily accessible location.

b. **Arc-Fault Circuit-Interrupter Protection shall be provided** on all 120-volt, single-phase, 15- and 20 ampere branch circuits supplying outlets or devices installed in dwelling unit kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas.

### 2.06 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory test panelboards according to NEMA PB 1.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. The fire rated listing or integrity of walls in which flush mounted panelboards are installed shall be maintained.

D. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

E. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

F. Provide required supports in accordance with Section 26 05 29.

G. Install panelboards plumb.

H. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

I. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
J. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.

K. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

L. Provide grounding and bonding in accordance with Section 26 05 26.
   1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
   2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

M. Install all field-installed branch devices, components, and accessories.

N. Provide fuses complying with Section 26 28 13 for fusible switches as indicated.

O. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

P. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

Q. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.

R. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

S. Provide filler plates to cover unused spaces in panelboards.

T. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
   1. Emergency and night lighting circuits.
   2. Fire detection and alarm circuits.
   3. Communications equipment circuits.
   4. Intrusion detection and access control system circuits.
   5. Video surveillance system circuits.

U. Identify panelboards in accordance with Section 26 05 53.

V. Directory cards shall be completely filled out with all circuits adequately marked and shall be typewritten. Room numbers shall be confirmed prior to completion. Spares shall be marked "SPARE". Spaces shall be marked "SPACE".

W. Provide facilities for future connection of additional loads. Two 1 inch spare conduits shall be stubbed out above ceiling or run to an accessible location from each flush mounted branch circuit panelboard. Two 2 inch spare conduits shall be stubbed out above ceiling or run to an accessible location from each flush mounted distribution panelboard.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

E. Test GFCI circuit breakers to verify proper operation.

F. Test AFCI circuit breakers to verify proper operation.

G. Test shunt trips to verify proper operation.

H. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.
B. Wall dimmers.
C. Receptacles.
D. Wall plates.
E. Floor box service fittings.
F. Poke-through assemblies.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 33.16 - Boxes for Electrical Systems.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
C. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R2015).
D. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
J. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
1. Wall Dimmers: Include derating information for ganged multiple devices.
2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR) for each protection mode, and diagnostics information.

C. Operation and Maintenance Data:
1. Wall Dimmers: Include information on operation and setting of presets.
2. GFCI Receptacles: Include information on status indicators.

D. Project Record Documents: Record actual installed locations of wiring devices.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide listed tamper resistant receptacles for receptacles, non-locking, 15 and 20 ampere installed in dwelling units per NEC 406.12.

E. Provide listed tamper resistant receptacles for receptacles, non-locking, 15 and 20 ampere installed in guest rooms and guest suites of hotels per NEC 406.12.

F. Provide listed tamper resistant receptacles for receptacles, non-locking 15 and 20 ampere installed in child care facilities per NEC 406.12.

G. Provide GFCI protection for receptacles installed within 6 feet of sinks.

H. Provide GFCI protection for receptacles installed in kitchens.

I. Provide GFCI protection for receptacles serving electric drinking fountains.

J. Unless noted otherwise, do not use combination switch/receptacle devices.

K. For flush floor service fittings, use tile rings for installations in tile floors.

L. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.02 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.

C. Wiring Devices Installed in Finished Spaces: White with white nylon wall plate.

D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.

E. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.

F. Isolated Ground Convenience Receptacles: Orange.
G. Surge Protection Receptacles: Blue.

H. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

I. Clock Hanger Receptacles: Brown with stainless steel wall plate.

J. Above-Floor Service Fittings: Gray wiring devices with satin aluminum housing.

K. Flush Floor Box Service Fittings: Gray wiring devices with aluminum cover and ring/flange.

L. Flush Poke-Through Service Fittings: Gray wiring devices with aluminum cover and aluminum flange.

M. Access Floor Boxes: Gray wiring devices with gray steel cover with insert to match floor covering.

2.03 WALL SWITCHES

A. Manufacturers:
   2. Pass & Seymour, a brand of Legrand North America, Inc; ______: www.legrand.us/#sle.

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with decorator style rocker type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Commercial specification grade, 20 A, 120/277 V with illuminated decorator style rocker type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

E. Pilot Light Wall Switches: Commercial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Commercial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Commercial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.
H. Locking Momentary Contact Wall Switches: Commercial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.04 WALL DIMMERS

A. Manufacturers:

B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

C. Dimmer switches shall be coordinated with lamps and ballasts shown to be dimmed. Ensure compatibility between dimmer switch and ballast, lamp type or LED driver within fixture.

D. Control: Slide control type with separate on/off switch.

E. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:
1. Incandescent: 600 W.
2. Magnetic Low-Voltage: 600 VA.
3. Electronic Low-Voltage: 400 VA.
4. Fluorescent: 600 VA.

F. Provide locator light, illuminated with load off.

G. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.05 RECEPTACLES

A. Manufacturers:
2. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
4. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. **Wiring Provisions:** Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.

2. **NEMA configurations specified are according to NEMA WD 6.**

3. **Hospital Grade Receptacles:** Listed as complying with UL 498 Supplement SD, with green dot hospital grade mark on device face.

**C. Convenience Receptacles:**

1. **Standard Convenience Receptacles:** Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.

2. **Automatically Controlled Convenience Receptacles:** Commercial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.

3. **Isolated Ground Convenience Receptacles:** Commercial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.

4. **Weather Resistant Convenience Receptacles:** Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

5. **Tamper Resistant Convenience Receptacles:** Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.

6. **Tamper Resistant and Weather Resistant Convenience Receptacles:** Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

7. **Illuminated Convenience Receptacles:** Commercial specification grade, 20A, 125V, NEMA 5-20R; illuminated face or indicator light to indicate power is being supplied to receptacle; single or duplex as indicated on the drawings.

**D. GFCI Receptacles:**

1. **GFCI Receptacles - General Requirements:** Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
   a. Provide test and reset buttons of same color as device.

2. **Standard GFCI Receptacles:** Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

3. **Weather Resistant GFCI Receptacles:** Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

4. **Tamper Resistant GFCI Receptacles:** Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

5. **Tamper Resistant and Weather Resistant GFCI Receptacles:** Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type.
complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

E. USB Charging Devices:
1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
   a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
   b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.
2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
3. USB Charging Noncombination Devices: Four-port (Type A); rectangular decorator style.

F. Surge Protection Receptacles:
1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 1449, Type 2 or 3.
   a. Energy Dissipation: Not less than 240 J per mode.
   b. Protected Modes: L-N, L-G, N-G.
   c. UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.
   d. Diagnostics:
3. Isolated Ground Surge Protection Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, with ground contacts isolated from mounting strap.

G. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.

H. Clock Hanger Receptacles: Single, 15A, 125V, NEMA 5-15R.

2.06 WALL PLATES

A. Manufacturers:

B. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Size: Standard; __________.
3. Screws: Metal with slotted heads finished to match wall plate finish.
C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

E. Aluminum Wall Plates: Smooth satin finish, clear anodized, factory-coated to inhibit oxidation.

F. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

G. Weatherproof Covers for Wet or Damp Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.
   1. Thomas & Betts: #CKLSVU(1-gang) and #2CKU (2-gang) or equal.

2.07 POKE-THROUGH ASSEMBLIES

A. Manufacturers:
   2. Wiremold, a brand of Legrand North America, Inc; _____:
      www.legrand.us/#sle.

B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

C. Flush Floor Service Fittings:
   1. Dual Service Flush Combination Outlets:
      a. Cover: Hinged door(s).
      b. Configuration:
         1. Power: One standard convenience duplex receptacle(s).
         2. Communications: __________.
         3. Voice and Data Jacks: Provided by others.
   2. Dual Service Flush Furniture Feed:
      a. Configuration:
         1. Power: One 3/4 inch threaded opening(s).
         2. Communications: Two 1/2 inch threaded opening(s).
   3. Accessories:
      a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that floor boxes are adjusted properly.

F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

G. Verify that core drilled holes for poke-through assemblies are in proper locations.

H. Verify that openings in access floor are in proper locations.

I. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
1. Mounting Heights: Unless otherwise indicated, as follows:
   a. Wall Switches: 48 inches above finished floor.
   b. Wall Dimmers: 48 inches above finished floor.
   c. Fan Speed Controllers: 48 inches above finished floor.
   d. Receptacles: 18 inches above finished floor or 6 inches above counter.
2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
3. Receptacles over-counter shall be mounted horizontally.
4. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
5. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
6. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Where receptacles are installed within one stud spacing width from a switch, the convenience outlet and switch shall align vertically.
D. Install wiring devices in accordance with manufacturer's instructions.

E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

I. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

J. Unless otherwise indicated, GFCI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFCI protection.

K. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

L. Install wiring devices plumb and level with mounting yoke held rigidly in place.

M. Install wall switches with OFF position down.

N. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

O. Do not share neutral conductor on branch circuits utilizing wall dimmers.

P. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

Q. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

R. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

S. Identify wiring devices in accordance with Section 26 05 53.

T. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

U. Match receptacles and special purpose outlets to Owner-furnished equipment, unless otherwise indicated. Coordinate receptacle Nema configuration with Owner-furnished equipment plug requirements.
3.04 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each wiring device for damage and defects.
C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
D. Test each receptacle to verify operation and proper polarity.
E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
F. Inspect each surge protection receptacle to verify surge protection is active.
G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING
A. Adjust devices and wall plates to be flush and level.
B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.06 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION
SECTION 26 28 13 - FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fuses.
B. Spare fuse cabinet.

1.02 RELATED REQUIREMENTS

A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
B. Section 26 05 73 - Power System Studies: Additional criteria for the selection of protective devices specified in this section.
C. Section 26 24 13 - Switchboards: Fusible switches.
D. Section 26 28 16.16 - Enclosed Switches: Fusible switches.

1.03 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
   1. Spare Fuse Cabinet: Include dimensions.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Fuses: One set(s) of three for each type and size installed.
   3. Fuse Pullers: One set(s) compatible with each type and size installed.
   4. Spare Fuse Cabinet Keys: Two.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation; ______: www.cooperindustries.com/#sle.

B. Littelfuse, Inc; ______: www.littelfuse.com/#sle.

C. Mersen; ______: ep-us.mersen.com/#sle.

2.02 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.
D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.
   1. Class RK1, Time-Delay Fuses:
   2. Class RK1, Fast-Acting, Non-Time-Delay Fuses:
   3. Class RK5, Time-Delay Fuses:
   4. Class RK5, Fast-Acting, Non-Time-Delay Fuses:

   1. Class J, Time-Delay Fuses:
   2. Class J, Fast-Acting, Non-Time-Delay Fuses:

I. Class L Fuses: Comply with UL 248-10.
   1. Class L, Time-Delay Fuses:
   2. Class L, Fast-Acting, Non-Time-Delay Fuses:


K. Class CC Fuses: Comply with UL 248-4.
   1. Class CC, Time-Delay Fuses:
   2. Class CC, Fast-Acting, Non-Time-Delay Fuses:

L. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

M. Provide the following accessories where indicated or where required to complete installation:
   1. Fuseholders: Compatible with indicated fuses.
   2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

2.03 SPARE FUSE CABINET

A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.

B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

C. Install spare fuse cabinet in convenient location in main electrical room unless otherwise indicated.

D. Identify spare fuse cabinet in accordance with Section 26 05 53.

END OF SECTION
SECTION 26 28 16.16 - ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS
   A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
   D. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.
   E. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS
   A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
   B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
   C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
   E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
   H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
D. Project Record Documents: Record actual locations of enclosed switches.
E. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. See Section 26 28 13 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. 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.
B. Handle carefully in accordance with manufacturer’s written instructions to avoid
damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and
after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Eaton Corporation; _____: www.eaton.com/#sle.
B. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
D. Source Limitations: Furnish enclosed switches and associated components produced
by the same manufacturer as the other electrical distribution equipment used for this
project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES
A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as
complying with UL 98; heavy duty; ratings, configurations, and features as indicated on
the drawings.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Unless otherwise indicated, provide products suitable for continuous operation under
the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
D. Horsepower Rating: Suitable for connected load.
E. Voltage Rating: Suitable for circuit voltage.
F. Short Circuit Current Rating:
   1. Provide enclosed safety switches, when protected by the fuses or supply side
      overcurrent protective devices to be installed, with listed short circuit current
      rating not less than the available fault current at the installed location as
determined by short circuit study performed in accordance with Section 26 05 73.
   2. Minimum Ratings:
      a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.
      b. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L,
or Class T Fuses: 200,000 rms symmetrical amperes.
      c. Double Throw Switches Protected by Class R, Class J, or Class T Fuses:
100,000 rms symmetrical amperes.
G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

H. Provide with switch blade contact position that is visible when the cover is open.

I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
   1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

M. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

O. Heavy Duty Switches:
   2. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
      a. Provide means for locking handle in the ON position where indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Provide required supports in accordance with Section 26 05 29.
E. Install enclosed switches plumb.
F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
G. Provide grounding and bonding in accordance with Section 26 05 26.
H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
J. Identify enclosed switches in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 32 13 - ENGINE GENERATORS

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:
   1. Engine and engine accessory equipment.
   2. Alternator (generator).
   3. Generator set control system.
   4. Generator set enclosure.

1.02  RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 23 11 13 - Facility Fuel-Oil Piping:
   1. Diesel fuel piping.
C. Section 23 51 00 - Breechings, Chimneys, and Stacks: Engine exhaust piping.
   1. Includes installation of exhaust silencer specified in this section.
D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
E. Section 26 05 29 - Hangers and Supports for Electrical Systems.
F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
G. Section 26 36 00 - Transfer Switches.

1.03  REFERENCE STANDARDS

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
D. NEMA MG 1 - Motors and Generators; 2016.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.
I. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

J. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
      a. Transfer Switches: See Section 26 36 00.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
   1. Include generator set sound level test data.
   2. Include characteristic trip curves for overcurrent protective devices upon request.
   3. Include alternator thermal damage curve upon request.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

E. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

F. Specimen Warranty: Submit sample of manufacturer’s warranty.

G. Evidence of qualifications for installer.

H. Evidence of qualifications for maintenance contractor (if different entity from installer).
I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

J. Manufacturer's factory emissions certification.

K. Manufacturer's certification that products meet or exceed specified requirements.

L. Source quality control test reports.

M. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
   1. Certified prototype tests.
   2. Torsional vibration compatibility certification.
   3. NFPA 110 compliance certification.
   4. Certified rated load test at rated power factor.

N. Manufacturer's detailed field testing procedures.

O. Field quality control test reports.

P. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

Q. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

R. Maintenance contracts.

S. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

T. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 30 (Flammable and Combustible Liquids Code).

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 100 miles of project site.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.
D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
   1. Contract maintenance office located within 100 miles of project site.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Packaged Engine Generator Set:

B. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 PACKAGED ENGINE GENERATOR SYSTEM
A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:

D. Packaged Engine Generator Set:
   1. Type: Diesel (compression ignition).
   2. Power Rating: kW as indicated on drawings, standby.
   3. Voltage: As indicated on drawings.
   4. Main Line Circuit Breaker:
      a. Type: Thermal magnetic.
      b. Trip Rating: Select according to generator set rating.

E. Generator Set General Requirements:
   1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
   2. Factory-assembled, with components mounted on suitable base.
   3. List and label engine generator assembly as complying with UL 2200.
   4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
   5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
   1. Altitude: 5500 feet.
   2. Ambient Temperature: Between -20 and 104 degrees F.

G. Starting and Load Acceptance Requirements:
   1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
   2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
   3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
   4. Maximum Load Step: Supports 100 percent of rated load in one step.
      a. Maximum Voltage Deviation with Load Step: 35 percent.
      b. Maximum Frequency Deviation with Load Step: 10 percent.
   5. Motor Starting Capability: Supports starting of motor load indicated with a maximum voltage dip of 35 percent.

H. Exhaust Emissions Requirements:
   1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Sound Level Requirements:
1. Do not exceed 89 dBA when measured at 23 feet from generator set in free field (no sound barriers) while operating at full load; include manufacturer's sound data with submittals.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):
1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
5. Fuel Tank Accessories: Provide NFPA 30 & 37 accessories which includes a 12'-0" above grade normal fuel cell vent extension, over fill prevention valve & fuel fill spill containment bucket.
6. Sub-Base Fuel Tank:
   a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
   b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
   c. Features:
      1. Direct reading fuel level gauge.
      2. Normal atmospheric vent.
      3. Emergency pressure relief vent.
      5. Dedicated electrical conduit stub-up area.
      7. Leak detection switch; located within secondary containment interstitial space for detection of primary tank fuel leak.

C. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
   a. Battery Type: Lead-acid.
   b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case
ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.

c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer’s recommendations for cable length to be installed.


4. Battery Charger:
   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
   c. Recognized as complying with UL 1236.
   d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
   e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
   f. Provide alarm output contacts as necessary for alarm indications.

5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

D. Engine Speed Control System (Governor):
   2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
   1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
   2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

F. Engine Cooling System:
   1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
   2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
   3. Ducted Radiators: Where ducted radiator air discharge is to be field-installed, provide suitable radiator duct flange/adapter.
   4. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer’s recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:
   1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer’s recommendations to meet sound performance requirements, where specified.

2.04 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:
   1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
   2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
   3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.05 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
   1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
   2. Generator Set Control Functions:
      a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
      c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
      d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
      e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).

g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.

3. Generator Set Status Indications:
   a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
   b. Current (Amps): For each phase.
   c. Frequency (Hz).
   d. Real power (W/kW).
   e. Reactive power (VAR/kVAR).
   f. Apparent power (VA/kVA).
   g. Power factor.
   h. Duty Level: Actual load as percentage of rated power.
   i. Engine speed (RPM).
   j. Battery voltage (Volts DC).
   k. Engine oil pressure.
   l. Engine coolant temperature.
   m. Engine run time.
   n. Generator powering load (position signal from transfer switch).

4. Generator Set Protection and Warning/Shutdown Indications:
   a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
      1. Overcrank (shutdown).
      2. Low coolant temperature (warning).
      3. High coolant temperature (warning).
      4. High coolant temperature (shutdown).
      5. Low oil pressure (shutdown).
      6. Overspeed (shutdown).
      7. Low fuel level (warning).
      8. Low coolant level (warning/shutdown).
      9. Generator control not in automatic mode (warning).
     10. High battery voltage (warning).
     11. Low cranking voltage (warning).
     12. Low battery voltage (warning).
   b. In addition to NFPA 110 requirements, provide the following protections/indications:
      1. High AC voltage (shutdown).
      2. Low AC voltage (shutdown).
      3. High frequency (shutdown).
      4. Low frequency (shutdown).
      5. Overcurrent (shutdown).
      6. Fuel tank leak (warning), where applicable.
   c. Provide contacts for local and remote common alarm.
   d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:
   a. Event log.

C. Remote Annunciator:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.

2. Generator Set Status Indications:
   a. Generator powering load (via position signal from transfer switch).
   b. Communication functional.

3. Generator Set Warning/Shutdown Indications:
   a. Comply with NFPA 110 for Level 1 systems including but not limited to the following indications:
      1. Overcrank (shutdown).
      2. Low coolant temperature (warning).
      3. High coolant temperature (warning).
      4. High coolant temperature (shutdown).
      5. Low oil pressure (warning).
      6. Low oil pressure (shutdown).
      7. Overspeed (shutdown).
      8. Low fuel level (warning).
      9. Low coolant level (warning/shutdown).
     10. Generator control not in automatic mode (warning).
     11. High battery voltage (warning).
     12. Low cranking voltage (warning).
     13. Low battery voltage (warning).
   b. Provide audible alarm with silence function.
   c. Provide lamp test function that illuminates all indicator lamps.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.06 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating, weather protective. Attenuation Level I: 70 to 89 d(B)A

B. Enclosure Material: Minimum 14 Gauge Steel.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

J. Enclosure Space Heater: Provide thermostatically controlled enclosure space heater to prevent condensation and improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

2.07 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

C. Generator Set production testing to include, at a minimum:
   1. Operation at rated load and rated power factor.
   2. Single step load pick-up.
   3. Transient and steady state voltage and frequency performance.
   4. Operation of safety shutdowns.

D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.
E. Unless otherwise indicated, mount generator set on properly sized 6 inch high concrete pad constructed in accordance with Section 03 30 00. Provide suitable vibration isolators, where not factory installed.

F. Provide required support and attachment in accordance with Section 26 05 29.

G. Use manufacturer’s recommended oil and coolant, suitable for the worst case ambient temperatures.

H. Provide diesel fuel piping and venting in accordance with Section 23 11 13, where not factory installed.

I. Provide engine exhaust piping in accordance with Section 23 51 00, where not factory installed.
   1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
   2. Do not exceed manufacturer’s maximum back pressure requirements.

J. Install exhaust silencer in accordance with Section 23 51 00, where not factory installed.

K. Provide grounding and bonding in accordance with Section 26 05 26.

L. Identify system wiring and components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer’s authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer’s detailed testing procedures and field reports with submittals.

C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

F. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer’s recommended torque settings.
   3. Check for proper oil and coolant levels.

G. Prepare and start system in accordance with manufacturer’s instructions.

H. Perform acceptance test in accordance with NFPA 110.

I. Inspection and testing to include, at a minimum:
   1. Verify compliance with starting and load acceptance requirements.
   2. Verify voltage and frequency; make required adjustments as necessary.
3. Verify phase sequence.
4. Verify control system operation, including safety shutdowns.
5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).

J. Provide field emissions testing where necessary for certification.
K. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
L. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES
A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Location: At project site.
E. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.06 PROTECTION
A. Protect installed engine generator system from subsequent construction operations.

3.07 MAINTENANCE
A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive
maintenance, systematic examination, adjustment, inspection, and testing, with a
detailed schedule.

C. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra
cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly
basis, based on actual time spent at site and not including travel time; include
hourly rate and definition of normal working hours in maintenance contract.

D. Maintain an on-site log listing the date and time of each inspection and call-back visit,
the condition of the system, nature of the trouble, correction performed, and parts
replaced.

END OF SECTION
SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Includes service entrance rated transfer switches.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 14 21 00 - Electric Traction Elevators: For interface with transfer switch.
C. Section 14 24 00 - Hydraulic Elevators: For interface with transfer switch.
D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
E. Section 26 05 29 - Hangers and Supports for Electrical Systems.
F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
G. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment specified in this section.
H. Section 26 21 00 - Low-Voltage Electrical Service Entrance.
   1. Includes Utility Company contact information.
I. Section 26 28 16.16 - Enclosed Switches: Safety switches not listed for use as transfer switch equipment.
J. Section 26 32 13 - Engine Generators: For interface with transfer switches.
   1. Includes code requirements applicable to work of this section.
   2. Includes additional testing requirements.
   3. Includes related demonstration and training requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

C. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
   1. Where applicable, include characteristic trip curves for overcurrent protective devices upon request.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
   1. Clearly indicate whether proposed short circuit current ratings are based on testing with specific overcurrent protective devices or time durations; indicate short-time ratings where applicable.

D. Specimen Warranty: Submit sample of manufacturer's warranty.

E. Evidence of qualifications for installer.

F. Evidence of qualifications for maintenance contractor (if different entity from installer).

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

H. Manufacturer's certification that products meet or exceed specified requirements.

I. Source quality control test reports.
J. Manufacturer’s detailed field testing procedures.

K. Field quality control test reports.

L. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

M. Executed Warranty: Submit documentation of final executed warranty completed in Owner’s name and registered with manufacturer.

N. Maintenance contracts.

O. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

P. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 200 miles of project site.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with power transfer systems of similar size, type, and complexity; manufacturer’s authorized installer.

E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
   1. Contract maintenance office located within 200 miles of project site.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer’s instructions.
B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Transfer Switches - Basis of Design: __________.

B. Transfer Switches - Other Acceptable Manufacturers:
   1. ASCO Power Technologies; _____: www.ascopower.com/#sle.
   3. Same as manufacturer of engine generator(s) used for this project.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

D. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize open transition transfer unless otherwise indicated or required.
   2. For transfer of highly inductive loads (e.g. large motors and transformers), utilize open transition transfer with in-phase monitor or delayed transition transfer.
3. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):
   a. Unless otherwise indicated or required, provide neutral switching:
      1. For systems with ground fault protection.
      2. Where the alternate/emergency source is a separately derived system.
   4. Provide signal before transfer contacts for transfer switches serving elevators.

D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Lugs for connection of power conductors shall be provided to accommodate the cabling indicated on the drawings.

F. Automatic Transfer Switch Number _____:
   1. Basis of Design: ____________.
   2. Transfer Switch Type: Automatic transfer switch.
   3. Transition Configuration: Open-transition (no neutral position).
   4. Voltage: As indicated on the drawings.
   5. Ampere Rating: As indicated on the drawings.
   6. Neutral Configuration: As indicated on the drawings.
   7. Load Served: As indicated on the drawings.
   8. Primary Source: As indicated on the drawings.
   9. Alternate Source: As indicated on the drawings.

G. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

H. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

I. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

J. Switching Methods:
   1. Open Transition:
      a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
      b. Where in-phase transfer is indicated, utilize in-phase monitor to initiate transfer when phase angle difference between sources is near zero to limit in-rush currents.
   2. Delayed Transition:
      a. Provide break-before-make transfer with programmable time delay in a neutral position not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
   3. Neutral Switching: Either simultaneously switched neutral (break-before-make) or overlapping neutral (make-before-break) methods are acceptable.
4. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

K. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.
   1. Altitude: 5500 feet.

L. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
      b. Outdoor Locations: Type 3R or Type 4.
   2. Provide lockable door(s) for outdoor locations.
   3. Finish: Manufacturer's standard unless otherwise indicated.

M. Short Circuit Current Rating:
   1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
   2. Short Time Rating: Where the requirement for selectivity is indicated, provide transfer switches with short time ratings suitable for the maximum short time delay setting of the supply side overcurrent protective device.

N. Automatic Transfer Switches:
   1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
   2. Control Functions:
      a. Automatic mode.
      b. Test Mode: Simulates failure of primary/normal source.
      c. Voltage and Frequency Sensing:
         1. Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
         2. Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
         3. Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
      d. Outputs:
         1. Contacts for engine start/shutdown (except where direct generator communication interface is provided).
         2. Auxiliary contacts; two set(s) for each switch position.
         3. Signal before transfer (load disconnect) contacts; for selective load disconnection prior to transfer.
      e. Adjustable Time Delays:
         1. Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
         2. Transfer to alternate/emergency source time delay.
         3. Retransfer to primary/normal source time delay.
         4. Signal before transfer (load disconnect) contact time delay.
5. Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.

f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.

g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.

h. Retransfer to Normal Switch: Bypasses time delays for retransfer to primary/normal source.

3. Status Indications:
   a. Connected to alternate/emergency source.
   b. Connected to primary/normal source.
   c. Alternate/emergency source available.
   d. Primary/normal source available.

4. Alarm Indications for Closed Transition Transfer Switches:
   a. Failure to synchronize.
   b. Extended source interconnection/transfer switch locked out.

5. Other Features:
   a. Event log.
   b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
   c. Remote monitoring capability via PC.

6. Automatic Sequence of Operations:
   a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
   b. Where applicable, initiate signal before transfer (load disconnect) contacts at programmable time before transfer.
   c. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
   d. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
   e. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

O. Service Entrance Rated Transfer Switches:
   1. Furnished with integral disconnecting and overcurrent protective device on the primary/normal source and with ground-fault protection where indicated.
   2. Listed and labeled as suitable for use as service equipment according to UL 869A.

P. Remote Annunciators:
   1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
   2. Transfer Switch Status Indications:
a. Connected to alternate/emergency source.
b. Connected to primary/normal source.
c. Alternate/emergency source available.

Q. Interface with Other Work:
1. Interface with engine generators as specified in Section 26 32 13.
2. Interface with elevators as specified in Section 14 21 00 and 14 24 00.
   a. Utilize signal before transfer contacts to disconnect elevator(s) served prior to transfer.

2.03 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.
C. Verify that rough-ins for field connections are in the proper locations.
D. Verify that mounting surfaces are ready to receive transfer switches.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer’s instructions.
   1. Manufacturer’s wiring diagrams shall be used to connect the equipment. All wiring and conduit shall be as called for in these specifications.
C. Arrange equipment to provide minimum clearances and required maintenance access.
D. Provide required support and attachment in accordance with Section 26 05 29.
E. Install transfer switches plumb and level.
F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
G. Provide grounding and bonding in accordance with Section 26 05 26.
H. Identify transfer switches and associated system wiring in accordance with Section 26 05 53.

I. Make all necessary connections.

### 3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Prepare and start system in accordance with manufacturer's instructions.

D. Automatic Transfer Switches:
   1. Inspect and test in accordance with NETA ATS, except Section 4.
   2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.
      a. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

E. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 32 13.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

### 3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

### 3.05 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

E. Coordinate with related generator demonstration and training as specified in Section 26 32 13.

3.06 PROTECTION
A. Protect installed transfer switches from subsequent construction operations.

3.07 MAINTENANCE
A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION
SECTION 26 43 00 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surge protective devices for service entrance locations.
B. Surge protective devices for distribution locations.
C. Surge protective devices for branch panelboard locations.

1.02 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 23 00 - Low-Voltage Switchgear.
C. Section 26 24 13 - Switchboards.
D. Section 26 24 16 - Panelboards.
E. Section 26 24 19 - Motor-Control Centers.
F. Section 26 25 13 - Low-Voltage Busways.

1.03 ABBREVIATIONS AND ACRONYMS
B. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.
1.06 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
   1. SPDs with EMI/RFI filter: Include noise attenuation performance.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

F. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

G. Project Record Documents: Record actual connections and locations of surge protective devices.

1.07 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.
1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices:
   1. Advanced Protection Technologies, Inc (APT); __________: www.aptsurge.com/#sle.

B. Factory-installed, Internally Mounted Surge Protective Devices:
   1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Protected Modes:

C. UL 1449 Voltage Protection Ratings (VPRs):
   1. Equivalent to basis of design.

D. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

E. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   1. Indoor clean, dry locations: Type 1.
   2. Outdoor locations: Type 3R.
2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

D. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.

E. Repetitive Surge Current Capacity: Not less than 5,000 impulses.

F. UL 1449 Nominal Discharge Current (I-n): 20 kA.

G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

H. Diagnostics:
   1. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.

I. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.04 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 or Type 2.

C. Distribution locations include SPDs connected to distribution panelboards, motor control centers, and busway.

D. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

E. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.

F. Repetitive Surge Current Capacity: Not less than 3,500 impulses.

G. UL 1449 Nominal Discharge Current (I-n): 20 kA.
H. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

I. Diagnostics:
   1. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.

J. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.05 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.
B. List and label as complying with UL 1449, Type 1 or Type 2.
C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.
D. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
E. Repetitive Surge Current Capacity: Not less than 2,000 impulses.
F. UL 1449 Nominal Discharge Current (I-n): 20 kA.
G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
H. Diagnostics:
   1. Protection Status Monitoring: Provide indicator lights to report the protection status.
I. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
C. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
D. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

E. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

F. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

G. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

H. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

3.04 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and
Supplementary Conditions and Division 01 Specification Sections, apply to this
Section.

1.02 SUMMARY

A. Section includes:

1. General luminaire requirements.
3. Luminaire support.

B. Related Requirements:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting,
including time switches, photoelectric relays, occupancy sensors, and multipole
lighting relays and contactors.

1.03 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
   a. Testing Agency Certified Data: For indicated luminaires, photometric data
certified by a qualified independent testing agency. Photometric data for
remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads,
required clearances, method of field assembly, components, and location and
size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. LEEDv4 - Sustainable Design Submittals:
   1. Product Data: Indicating luminaire is certified by ENERGY STAR.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on
which the following items are shown and coordinated with each other, using input from
installers of the items involved:
   1. Luminaires.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of
the plane of the luminaires.
   4. Structural members to which equipment or luminaires will be attached.
   5. Initial access modules for acoustical tile, including size and locations.
   6. Items penetrating finished ceiling, including the following:
      a. Other luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Ceiling-mounted projectors.
   7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.
1.06 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
      1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.07 QUALITY ASSURANCE
   1. 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, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
      2. Luminaires with Integral Lamps: Provide luminaires from a single manufacturer for each luminaire type.

1.08 DELIVERY, STORAGE, AND HANDLING
   A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.09 WARRANTY
   A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
      B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   B. Standards:
      1. ENERGY STAR certified.
      2. California Title 24 compliant.
      3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

5. UL Listing: Listed for damp location.

6. Recessed luminaires shall comply with NEMA LE 4.

7. User Replaceable Lamps:
   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61.

C. CRI of minimum 80. CCT as indicated on drawings.

D. Rated lamp life of 50,000 hours to L70.

E. Lamps dimmable from 100 percent to 0 percent of maximum light output.

F. Internal driver.

G. Nominal Operating Voltage: 120 or 277 V ac.

H. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.02 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI for all luminaires.

2.03 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.
2.04 LUMINAIRE SUPPORT

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.


D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.03 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls or attached to a minimum 20 gauge backing plate attached to wall structural members.
   2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:
   1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
   2. Ceiling mount with four-point pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
   3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
   4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
3.04 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.06 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 51 19
SECTION 26 52 19 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Emergency lighting luminaires.
2. Emergency lighting units.
3. Internally lighted exit signs.
4. Luminaire supports.

1.03 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
D. Fixture: See "Luminaire" Paragraph.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
   
   a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
   
   b. Manufacturers’ Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.
   
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. LEEDv4 - Sustainable Design Submittals:
   
   1. Product Data: Indicating luminaire is certified by ENERGY STAR.
   2. Product Data: For lamps, indicating mercury content and lamp life.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   
   1. Luminaires.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
   4. Structural members to which equipment will be attached.
   5. Size and location of initial access modules for acoustical tile.
   6. Items penetrating finished ceiling including the following:
      
      a. Other luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Ceiling-mounted projectors.
      e. Sprinklers.
      f. Access panels.
   
   7. Moldings.

B. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.
1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers’ codes.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Signs: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Luminaire-mounted, emergency battery pack: One for every 50 emergency lighting units. Furnish at least one of each type.

1.08 QUALITY ASSURANCE

1. 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, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer’s standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
2. Warranty Period for Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for fluorescent luminaires.

F. Lamp Base: Comply with ANSI C81.61.

G. Bulb Shape: Complying with ANSI C79.1.

H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with driver.

1. Emergency Connection: Operate continuously at an output of 1400 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.

2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
   b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
   c. Humidity: More than 95 percent (condensing).
   d. Altitude: Exceeding 3300 feet.

4. Nightlight Connection: Operate lamp continuously at 40 percent of rated light output.

5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.


7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

I. External Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.

2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.


5. Charger: Fully automatic, solid-state, constant-current type.

6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.

7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

9. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

10. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.02 EMERGENCY LIGHTING LUMINAIRES

A. General: Provide self-contained units.
2.03 EMERGENCY LIGHTING UNITS

A. General: Provide self-contained units.

2.04 INTERNALLY LIGHTED EXIT SIGNS

A. General: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

2.05 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:
   1. Smooth operating, free of light leakage under operating conditions.
   2. Designed to permit relamping without use of tools.
   3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:
   1. Clear, UV-stabilized acrylic.
   2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.06 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

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

3.02 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:
   1. Sized and rated for luminaire and emergency power unit weight.
   2. Able to maintain luminaire position when testing emergency power unit.
   3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls or attached to a minimum 20-gage backing plate attached to wall structural members.
   2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.

4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.03 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.05 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.

2. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.06 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.

   a. Parts and supplies shall be manufacturer’s authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 26 52 19
SECTION 26 56 13 - LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY
A. Section Includes:
   1. Lighting poles of following type(s):
      a. Aluminum poles.
   2. Pole accessories including:
      a. Duplex receptacles.
   3. Pole base mounting hardware.

1.03 DEFINITIONS
A. EPA: Equivalent projected area.
B. Luminaire: Complete lighting fixture.
C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.
D. Standard: See "Pole."

1.04 ACTION SUBMITTALS
A. Product Data:
   1. For the following, arranged as indicated:
      a. Each pole.
      b. Each pole accessory.
      c. Each luminaire supporting device.
   2. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
3. Include finishes for lighting poles and luminaire-supporting devices.
4. Anchor bolts.
5. Manufactured pole foundations.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of following:
   a. Poles.
   b. Pole accessories.

4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For the following to include in operation and maintenance manuals.
   a. Poles.

2. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Aluminum Poles: Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.
1.07 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace following components 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 a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period:
   a. Aluminum Poles: Five years from date of Substantial Completion.

2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Foundation Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design pole foundation.

B. Structural Characteristics: Comply with AASHTO LTS-6-M.

1. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
2. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.
3. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.
4. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

a. Basic wind speed for calculating wind load for poles exceeding 50 feet in height is 100 mph.
   1) Wind Importance Factor: 1.0.
   3) Velocity Conversion Factor: 1.0.

b. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph.
   1) Wind Importance Factor: 1.0.
   3) Velocity Conversion Factor: 1.0.
c. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

C. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.02 ALUMINUM POLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product submitted for review.

B. Poles:
   1. Seamless, extruded structural tube complying with ASTM B 221, Alloy 6063-T6, with access handhole in pole wall.
   2. Seamless, extruded structural tube complying with ASTM B 221, Alloy 6061-T6, with access handhole in pole wall.
   3. Shape: As indicated on drawings.
   4. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Mast Arms: Aluminum type, continuously welded to pole attachment plate. Material and finish same as plate.

D. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with stainless-steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

F. Grounding and Bonding Lugs: Bolted 1/2-inch threaded lug, complying with requirements in Section 26 05 26 “Grounding and Bonding for Electrical Systems,” listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Fasteners:
   1. For Structural Applications: Galvanized steel <Insert finish or grade>, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
a. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.

b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

2. For Non-Structural Applications: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

H. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

J. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.

4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; 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.

K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As indicated on drawings.

L. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Powder coat shall comply with AAMA 2604.
   a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils dry film thickness; cured according to manufacturer’s instructions. Coat interior and exterior of pole for equal corrosion protection.
   b. Color: As indicated on drawings.

2.03 POLE ACCESSORIES

A. Duplex Receptacle: Ground-fault circuit interrupter type, 120 V ac, 20 A in a weatherproof assembly. Comply with requirements in Section 26 27 26 “Wiring Devices.”
   1. Surface mounted 12 inches above finished grade.
      a. NEMA 250, Type 3R, nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.
      b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.
   2. Recessed 12 inches above finished grade.
      a. NEMA 250, Type 3R, nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.
      b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.

2.04 POLE BASE MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi.
   1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
   2. Threading: Uniform National Coarse, Class 2A.

B. Nuts: ASTM A 563, Grade A, Heavy-Hex
   1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
   2. Four nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.

C. Washers: ASTM F 436, Type 1.
1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Two washers provided per anchor bolt.

2.05 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

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

3.02 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Pre-Cast Foundations: Factory fabricated, 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. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

C. 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.
1. **Baseplate**: Stamped with manufacturer's name, date of production, and cable entry.

**D. Direct-Buried Foundations**: Install to depth indicated on Drawings, but not less than one-sixth of pole height. Add backfill in 6-inch to 9-inch layers, tamping each layer before adding the next or as shown on Drawings. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

**E. Direct-Buried 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. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

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 grout. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

**F. Anchor Bolts**: Install plumb using manufacturer-supplied plywood template, uniformly spaced.

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3.03 **POLE INSTALLATION**

**A. Alignment**: Align poles as indicated.

**B. Clearances**: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

1. **Fire Hydrants and Water Piping**: 60 inches.
2. **Water, Gas, Electric, Communications, and Sewer Lines**: 10 feet.
3. **Trees**: 15 feet from tree trunk.

**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 Section 03 30 00 "Cast-in-Place Concrete."

**D. Foundation-Mounted Poles**: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
2. Install base covers unless otherwise indicated.
3. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
E. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.04 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.05 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.07 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Inspect poles for nicks, mars, dents, scratches, and other damage.
2. System function tests.

B. Prepare test and inspection reports.

END OF SECTION 26 56 13
SECTION 26 56 19 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. General luminaire requirements.
2. Exterior solid-state luminaires that are designed for and exclusively use LED technology.
3. Luminaire-mounted photoelectric relays.
4. Luminaire supports.

B. Related Requirements:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 26 09 43 "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
3. Section 26 56 13 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.03 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output luminaire.

F. Luminaire: Complete lighting unit, including light source, reflector, and housing.
1.04 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Light sources; include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79 and IES LM-80.
   a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. LEEDv4 - Sustainable Design Submittals:

1. Product Data: BUG ratings.
2. Product Data: Luminaire calculations.
3. Product Data: Indicating luminaire is certified by ENERGY STAR.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Structural members to which equipment and luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.
6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
   1. Provide a list of all luminaire types used on Project. Use ANSI and manufacturers’ codes.
   2. Provide a list of all photoelectric relay types used on Project; use manufacturers’ codes.

1.07 QUALITY ASSURANCE

A. Provide luminaires from a single manufacturer for each luminaire type.
   1. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.09 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including luminaire support components.
      b. Faulty operation of luminaires and accessories.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

   2. Warranty Period: 2 years from date of Substantial Completion.
PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 1598 and listed for wet location where indicated on Drawings Luminaire Schedule.

C. Luminaire Rating: Lamp marked for outdoor use.

D. Source Limitations: Obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.02 SCHEDULED EXTERIOR LED LUMINAIRE TYPES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the following:

   1. Product indicated on Drawings Luminaire Schedule or approved equal.

2.03 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the following:

   1. Product indicated on Drawings Luminaire Schedule.

   B. Comply with UL 773 or UL 773A.

   C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

       1. Relay with locking-type receptacle shall comply with ANSI C136.10.
       2. Adjustable window slide for adjusting on-off set points.

2.04 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
2.05 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine structures and surfaces including, but not limited to, the following for suitable conditions where luminaires will be installed.
   1. Walls.
   2. Roofs.
   3. Canopy ceilings.
   4. Overhang ceilings.

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

3.02 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Fasten luminaire to structural support.

D. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls.
   2. Attached to a minimum 1/8 inch backing plate attached to wall structural members.
   3. Attached using through bolts and backing plates on either side of wall.

F. Ground-Mounted Luminaire Support: Install on concrete base as indicated on Drawings.


H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

I. Install luminaires at height and aiming angle as indicated on Drawings.

J. Coordinate layout and installation of luminaires with other construction.

K. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

L. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 33 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.04 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top dimension above finished grade or surface at luminaire location as indicated on drawings. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.05 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base flush with finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."
3.06 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 Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.07 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.08 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. 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 IES testing guide(s):
   c. IES LM-52 Photometric Measurements of Roadway Sign Installations.
   d. IES LM-64 Photometric Measurements of Parking Areas.
   e. IES LM-72 Directional Positioning of Photometric Data.
2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. 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.
3.09 DEMONSTRATION AND TRAINING

A. Demonstrate to Owner’s personnel operation of luminaires.

B. Train Owner’s maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace luminaires that are defective.
2. Parts and supplies shall be manufacturer’s authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 56 19
SECTION 27 10 00 - STRUCTURED CABLELING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Communications system design requirements.
B. Communications pathways.
C. Copper cable and terminations.
D. Fiber optic cable and interconnecting devices.
E. Communications equipment room fittings.
F. Communications outlets.
G. Communications grounding and bonding.
H. Communications identification.

1.02  RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   1. Includes intersystem bonding termination.
   2. Includes bonding jumpers for bonding of communications systems and electrical
      system grounding.
C. Section 26 05 33.13 - Conduit for Electrical Systems.
D. Section 26 05 33.16 - Boxes for Electrical Systems.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products.
F. Section 26 27 26 - Wiring Devices.

1.03  REFERENCE STANDARDS

A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic
   Industries Alliance/Electrical Components Association; Revision E, 2005.
C. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor
   Cables (With or Without An Overall Shield) For Use in General Purpose and LAN
   Communications Wiring Systems Technical Requirements; 2012.
D. NECA/BICSI 568 - Standard for Installing Building Telecommunications Cabling;
   National Electrical Contractors Association; 2006.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
   3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Arrange for Communications Service Provider to provide service.

C. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for each product.

C. Sustainable Design Documentation: Submit manufacturer’s product data on cable and cable insulation showing compliance with specified lead content requirements.

D. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).

E. Evidence of qualifications for installer.

F. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.

G. Field Test Reports.

H. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
   1. Record actual locations of outlet boxes and distribution frames.
   2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
   3. Identify distribution frames and equipment rooms by room number on contract drawings.

I. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.06 QUALITY ASSURANCE

A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

B. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.

C. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
   1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
2. Supervisors and installers factory certified by manufacturers of products to be installed.
3. Employing BICSI Registered Cabling Installation Technicians (RCIT) for supervision of all work.

D. Products: Listed, classified, and labeled as suitable for the purpose intended.
E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer’s unopened packaging until ready for installation.
B. Keep stored products clean and dry.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Cabling and Equipment:
   1. CommScope; _________: www.commscope.com/#sle
   2. 3M Communications Technologies; _________: solutions.3m.com/#sle

2.02 SYSTEM DESIGN
A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
   2. Comply with Communications Service Provider requirements.
   3. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
   4. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
   5. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
B. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.
   1. Locate main distribution frame as indicated on the drawings.
2. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.

C. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
   1. Locate intermediate distribution frames as indicated on the drawings.

D. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.

E. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.03 PATHWAYS

A. Conduit: As specified in Section 26 05 33.13; provide pull cords in all conduit.


2.04 COPPER CABLE AND TERMINATIONS

A. Copper Backbone Cable:
   1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2, ICEA S-90-661, and listed and labeled as complying with UL 444; arranged in 25-pair binder groups.
   2. Cable Type: TIA-568.2 Category 3 UTP (unshielded twisted pair); 24 AWG.
   3. Cable Capacity: Quantity of pairs as indicated on drawings.
   4. Cable Applications:
      a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
      b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.

B. Copper Horizontal Cable:
   1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
   2. Cable Type - Voice and Data: TIA-568.2 Category 6 UTP (unshielded twisted pair); 23 AWG.
   3. Cable Capacity: 4-pair.
   4. Cable Applications:
      a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
      b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.
      c. General Purpose Applications: Use listed NFPA 70 Type CM/CMG general purpose cable, Type CMR riser cable, or Type CMP plenum cable.
   5. Cable Jacket Color - Voice and Data Cable: Blue.

C. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
   1. Performance: 500 mating cycles.
   2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.

E. Copper Patch Cords:
   1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
   2. Patch Cords for Patch Panels:
      a. Quantity: One for each pair of patch panel ports.
   3. Patch Cords for Work Areas:
      a. Quantity: One for each work area outlet port.

2.05 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

A. Fiber Optic Backbone Cable:
   1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
   2. Cable Type: Multimode, laser-optimized 50/125 um (OM3) complying with TIA-492AAAC.
   3. Cable Capacity: Quantity of fibers as indicated on drawings.
   4. Cable Applications:
      a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
      b. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.
   5. Cable Jacket Color:

B. Fiber Optic Horizontal Cable:
   1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
   2. Cable Type: Multimode, laser-optimized 50/125 um (OM3) complying with TIA-492AAAC.
   3. Cable Capacity: 2-fiber.
   4. Cable Applications:
      a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
      b. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.
      c. General Applications: Use listed NFPA 70 Type OFN/OFNG general purpose cable, Type OFNR riser cable, or Type OFNP plenum cable.
   5. Cable Jacket Color:
C. Fiber Optic Interconnecting Devices:
   1. Connector Type: Type SC.
   2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
   3. Maximum Attenuation/Insertion Loss: 0.3 dB.

D. Fiber Optic Patch Cords:
   1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
   2. Patch Cords for Patch Panels:
      a. Quantity: One for each pair of patch panel ports.
   3. Patch Cords for Work Areas:
      a. Quantity: One for each work area outlet port.

2.06 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

A. Copper Cross-Connection Equipment:
   1. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
      a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
      b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
      c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
      d. Provide incoming cable strain relief and routing guides on back of panel.

B. Fiber Optic Cross-Connection Equipment:
   1. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
      a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adaptors per standard panel width.
      b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
      c. Provide incoming cable strain relief and routing guides on back of panel.
      d. Provide rear cable management tray at least 8 inches deep with removable cover.
      e. Provide dust covers for unused adapters.

C. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
   1. Size: 48 by 96 inches.
   2. Do not paint over UL label.

D. Equipment Racks and Cabinets: EIA/ECA-310 standard 19 inch wide component racks.
   1. Wall Mounted Racks: Steel construction, hinged to allow access to back of installed components.
2. Floor Mounted Racks: Aluminum or steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
3. Freestanding Cabinets: Front and rear doors with locks; removable side panels with locks; vented top and rear door; adjustable leveling feet; cable access in roof and base; grounding bar.
4. Wall Mounted Cabinets: Front doors with locks, louvered side panels, top and bottom cable access, and ground lug.
   a. Cover inside of cabinet back with plywood backboard as specified.
   b. Duplex AC power outlet inside cabinet.
5. Cabinets: Steel construction with corrosion resistant finish.

2.07 COMMUNICATIONS OUTLETS

A. Outlet Boxes: Comply with Section 26 05 33.16.
   1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
   2. Minimum Size, Unless Otherwise Indicated:
      a. Voice Only Outlets: 4 inch by 2 inch by 2-1/8 inch deep (100 by 50 by 54 mm) trade size.
      b. Data or Combination Voice/Data Outlets: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
      c. Fiber Optic Outlets: 4-11/16 inch square by 2-1/8 inch deep (119 by 54 mm) trade size.

B. Wall Plates:
   1. Comply with system design standards and UL 514C.
   2. Accepts modular jacks/inserts.
   3. Capacity:
      a. Voice Only Outlets: 2 ports.
      b. Data or Combination Voice/Data Outlets: 2 ports.
      c. Fiber Optic Outlets: 2 simplex/1 duplex couplers.

2.08 GROUNDING AND BONDING COMPONENTS

A. Comply with TIA-607.
B. Comply with Section 26 05 26.

2.09 IDENTIFICATION PRODUCTS

A. Comply with TIA-606.
B. Comply with Section 26 05 53.
2.10 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), NECA/BICSI 568, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

B. Comply with Communication Service Provider requirements.

C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

3.02 INSTALLATION OF PATHWAYS

A. Install pathways with the following minimum clearances:
   1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
   2. 12 inches from power conduits and cables and panelboards.
   3. 5 inches from fluorescent and high frequency lighting fixtures.
   4. 6 inches from flues, hot water pipes, and steam pipes.

B. Conduit, in Addition to Requirements of Section 26 05 33.13:
   1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
   2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.
   3. Arrange conduit to provide no more than 100 feet between pull points.
   4. Do not use conduit bodies.
   5. Minimum Cover - Underground Service Entrance: Comply with NFPA 70 and Communications Service Provider requirements.

C. Outlet Boxes:
   1. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of telecommunications outlets provided under this section.
      a. Mounting Heights: Unless otherwise indicated, as follows:
         1. Telephone and Data Outlets: 18 inches above finished floor.
         2. Telephone Outlets for Side-Reach Wall-Mounted Telephones: 54 inches above finished floor to top of telephone.
         3. Telephone Outlets for Forward-Reach Wall-Mounted Telephones: 48 inches above finished floor to top of telephone.
      b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
c. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
d. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
e. Locate outlet boxes so that wall plate does not span different building finishes.
f. Locate outlet boxes so that wall plate does not cross masonry joints.

3.03 INSTALLATION OF EQUIPMENT AND CABLES

A. Cabling:
1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
2. Do not over-cinch or crush cables.
3. Do not exceed manufacturer's recommended cable pull tension.
4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches.
2. At Outlets - Copper: 12 inches.
3. At Outlets - Optical Fiber: 39 inches.

C. Copper Cabling:
1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
3. Use T568B wiring configuration.

D. Fiber Optic Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
2. Support vertical cable at intervals as recommended by manufacturer.

E. Wall-Mounted Racks and Enclosures:
1. Install to plywood backboards only, unless otherwise indicated.
2. Mount so height of topmost panel does not exceed 78 inches above floor.

F. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.

G. Identification:
1. Use wire and cable markers to identify cables at each end.
2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.
3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Comply with inspection and testing requirements of specified installation standards.

C. Visual Inspection:
   1. Inspect cable jackets for certification markings.
   2. Inspect cable terminations for color coded labels of proper type.
   3. Inspect outlet plates and patch panels for complete labels.

D. Testing - Copper Cabling and Associated Equipment:
   1. Test backbone cables after termination but before cross-connection.
   2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
   3. Test operation of shorting bars in connection blocks.
   5. Category 3 Links: Test each pair for short circuit continuity, short to ground, crosses, reversed polarity, operational and ring-back, and dial tone.

E. Testing - Fiber Optic Cabling:
   1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
   4. Links: Perform optical fiber end-to-end attenuation tests and field reel tests.

F. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION
SECTION 28 10 00 - ACCESS CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Access control system requirements.
B. Access control units and software.
C. Access control point peripherals, including readers.
D. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.
B. Section 08 7100 - Door Hardware: Electrically operated door hardware, for interface with access control system.
   1. Includes door hardware with integral request to exit devices.
C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
D. Section 26 0533.13 - Conduit for Electrical Systems.
E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
F. Section 27 1005 - Structured Cabling for Voice and Data - Inside-Plant: Data cables for access control system IP network connections.
G. Section 28 2000 - Video Surveillance: For interface with access control system.
H. Section 28 4600 - Fire Detection and Alarm: For interface with access control system.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other installers to provide suitable door hardware as required for both access control functionality and code compliance.

2. Coordinate the placement of readers with millwork, furniture, equipment, etc. installed under other sections or by others.

3. Coordinate the work with other installers to provide power for equipment at required locations.

4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:
   1. Conduct meeting with facility representative to review reader and equipment locations.
   2. Conduct meeting with facility representative and other related equipment manufacturers to discuss access control system interface requirements.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

D. Design Data: Standby battery/UPS calculations.

E. Certify that proposed system design and components meet or exceed specified requirements.

F. Evidence of qualifications for installer.

G. Evidence of qualifications for maintenance contractor (if different entity from installer).

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

I. Manufacturer’s detailed field testing procedures.

J. Field quality control test reports.

K. Maintenance contracts.
L. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

M. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

N. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

O. Software: One copy of software not resident in read-only memory.

P. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70.
   3. The requirements of the local authorities having jurisdiction.
   4. Applicable TIA/EIA standards.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with access control systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.
   1. Contract maintenance office located within 200 miles of project site.

D. Maintenance Contractor Qualifications: Same entity as installer.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer’s instructions.

B. Store products in manufacturer’s unopened packaging, keep dry and protect from damage until ready for installation.
1.08 FIELD CONDITIONS
   A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY
   A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
   B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Access Control System - Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier

2.02 ACCESS CONTROL SYSTEM REQUIREMENTS
   A. Provide new access control system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
   B. System Battery Backup: Provide batteries/uninterruptible power supplies (UPS) as required for 90 minutes full operation.
   C. Surge Protection:
      1. Provide surge protection for readers and door strikes/locks.
      2. Provide equipment power surge protection where electrical distribution system surge protection is not provided.
   D. Access Control Points:
      1. See article "ACCESS CONTROL POINT PERIPHERALS" below for device descriptions.
   E. Computers Required:
      1. See article "ACCESS CONTROL UNITS AND SOFTWARE" below for product descriptions.
      2. Controller(s):
         a. Quantity: One.
         b. Location(s): MDF room.
      3. Remote Node(s):
         a. Quantity: As Required.
         b. Location(s): To be determined.
4. Badging Station Computer(s):
   a. Quantity: Provide as optional pricing.
   b. Location(s): To be determined.
   c. Peripherals required for each badging station computer:
      1) Mouse and keyboard.
      2) Monitor(s): One.
      3) CPU
      4) Badging printer.
      5) Badging camera.
      6) Badging Software package.

F. Interface with Other Systems:
   1. Provide products compatible with other systems requiring interface with access control system.
   2. Interface with electrically operated door hardware as specified in Section 08 7100.
      a. Capable of locking/unlocking/releasing controlled doors.
      b. Capable of receiving input from integral door hardware switches.
   3. Interface with video surveillance system as specified in Section 28 2000.
      a. Capable of affecting camera/video operation for selected access control system events.
   4. Interface with fire alarm system as specified in Section 28 4600.
      a. Capable of affecting access for designated doors for selected fire alarm system events.

G. Provide products listed, classified, and labeled as suitable for the purpose intended.
   1. Access Control Units and Readers: Listed and labeled as complying with UL 294.
   2. Integrated Burglar Alarm/Access Control Equipment: Also listed and labeled as complying with UL 1076.

2.03 ACCESS CONTROL UNITS AND SOFTWARE
   A. Provide access control units and associated software compatible with readers to be connected.

2.04 ACCESS CONTROL POINT PERIPHERALS
   A. Provide devices compatible with control units.
   B. Provide devices suitable for operation under the service conditions at the installed location.
   C. Provide readers compatible with credentials to be used.
D. Reader Color: To be selected by Architect from manufacturer’s available standard colors.

E. Contactless Smart Card Readers:
   1. Utilizes 13.56 Mhz RF communication with compatible credentials.
   2. Utilizes 64 bit authentication keys.
   4. Supports data encryption.

F. Door Position Switches:
   1. Magnetic Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors.
   2. Contact Color: To be selected by Architect from manufacturer’s available standard colors.

G. Door Locking Devices (Electric Strikes and Magnetic Locks): Comply with Section 08 7100.

2.05 ACCESSORIES

A. Provide components as indicated or as required for connection of access control system to devices and other systems indicated.

B. Unless otherwise indicated, credentials to be provided by Contractor.
   1. Provide credentials compatible with readers and control units/software to be used.

C. Unless otherwise indicated, network switches required for network connections to system components to be provided by Contractor.

D. Provide cables as indicated or as required for connections between system components.
   1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP), minimum Category 6, complying with Section 27 1005.

E. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.

E. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

A. Install access control system in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer’s instructions.

C. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
   1. Use suitable listed cables in wet locations, including underground raceways.
   2. Use suitable listed cables for vertical riser applications.
   3. Use listed plenum rated cables in spaces used for environmental air.
   4. Install wiring in conduit for the following:
      a. Where required for rough-in.
      b. Where required by authorities having jurisdiction.
      c. Where exposed to damage.
      d. Where installed outside the building.
      e. For exposed connections from outlet boxes to devices.
   5. Conduit: Comply with Section 26 0533.13.
   6. Conceal all cables unless specifically indicated to be exposed.
   7. Use power transfer hinges complying with Section 08 7100 for concealed connections to door hardware.
   8. Cables in the following areas may be exposed, unless otherwise indicated:
      a. Equipment closets.
      b. Within joists in areas with no ceiling.
   9. Route exposed cables parallel or perpendicular to building structural members and surfaces.
   10. Do not exceed manufacturer’s recommended maximum cable length between components.

D. Provide grounding and bonding in accordance with Section 26 0526.

E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

F. Identify system wiring and components in accordance with Section 26 0553.

G. Provide initial programming to include at a minimum:
   1. Door portal programming and identification for a fully functional system
   2. Portal access to include 5 user groups, 5 portal groups.
   3. Set up of 4 schedules to include holidays, after hours, regular hours and TBD.
   4. Association of portals with cameras.
3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
C. Prepare and start system in accordance with manufacturer's instructions.
D. Program system parameters according to requirements of Owner.
E. Test for proper interface with other systems.
F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Location: At project site.

3.06 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.07 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of access control system for two years from date of
Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

C. Provide trouble call-back service upon notification by Owner:
   1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION
SECTION 28 2000 - VIDEO SURVEILLANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Video surveillance system requirements.
B. Video recording and viewing equipment.
C. Cameras.
D. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.
B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
C. Section 26 0529 - Hangers and Supports for Electrical Systems.
D. Section 26 0533.13 - Conduit for Electrical Systems.
E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
F. Section 27 1005 - Structured Cabling for Voice and Data - Inside-Plant: Data cables for IP video surveillance system network connections.
G. Section 28 1000 - Access Control: For interface with video surveillance system.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
   2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.
3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:
   1. Conduct meeting with facility representative to review camera and equipment locations and camera field of view objectives.
   2. Conduct meeting with facility representative and other related equipment manufacturers to discuss video surveillance system interface requirements.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer’s standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

D. Design Data:
   1. Standby battery/UPS calculations.
   2. Video storage capacity calculations.

E. Certify that proposed system design and components meet or exceed specified requirements.

F. Evidence of qualifications for installer.

G. Evidence of qualifications for maintenance contractor (if different entity from installer).

H. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

I. Manufacturer’s detailed field testing procedures.

J. Field quality control test reports.

K. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.
L. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

M. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

N. Maintenance contracts.

O. Software: One copy of software not resident in read-only memory.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70.
   2. Applicable TIA/EIA standards.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.
   1. Contract maintenance office located within 200 miles of project site.

E. Maintenance Contractor Qualifications: Same entity as installer.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.
1.08 FIELD CONDITIONS
A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY
A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Video Recording and Viewing Equipment - Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.
B. Cameras - Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 VIDEO SURVEILLANCE SYSTEM
A. Provide new video surveillance system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description: IP system with connection to network (IP) cameras.
   1. Video Storage Capacity: Suitable for storing video from all cameras for 30 days.
   2. System Battery Backup: Provide batteries/uninterruptible power supplies (UPS) as required for 360 minutes full operation.
   3. Surge Protection:
      a. Provide surge protection for exterior cameras.
      b. Provide equipment power surge protection where electrical distribution system surge protection is not provided.

C. Cameras Required:
   1. See article "CAMERAS" below for product descriptions.

D. Video Recording and Viewing Equipment Required:
   1. See article "VIDEO RECORDING AND VIEWING EQUIPMENT" below for product descriptions.

E. Interface with Other Systems:
1. Provide products compatible with other systems requiring interface with video surveillance system.

2. Interface with access control system as specified in Section 28 1000.
   a. Capable of affecting camera/video operation for selected access control system events.

F. Provide products listed, classified, and labeled as suitable for the purpose intended.


2.03 VIDEO RECORDING AND VIEWING EQUIPMENT

A. Provide video recording and viewing equipment compatible with cameras to be connected.

B. Network Video Recorders (NVRs):
   1. Supports connection of network (IP) cameras.
   2. Supports continuous and event-based recording.
   3. Network Video Recorder Type _____:
      a. Capacity: License as required.
      b. Recording and Viewing Performance: 10 fps at 1080P resolution. Assume 30% motion.
      c. Storage Capacity: As required. Minimum 4 TB.
      d. Removable Media: NA.
      e. Network: Single 1 Gigabit Ethernet.

C. Computers:
   1. Workstation Computers: Unless otherwise indicated, workstation computer hardware is provided by the end user.
   2. Servers: Unless otherwise indicated, server hardware not furnished by video surveillance system manufacturer to be provided by Contractor as part of work of this section, meeting video surveillance system equipment manufacturer's minimum requirements.

D. Software:
   1. Unless otherwise indicated, provide all software and licenses required for fully operational system.

E. Monitors:
   1. Unless otherwise indicated, monitors to be provided by the end user.
2.04 CAMERAS

A. Provide cameras and associated accessories suitable for operation under the service conditions at the installed location. Provide additional components (e.g. enclosures, heaters, blowers, etc.) as required.

B. Where not factory-installed, provide additional components (e.g. lenses, mounting accessories, etc.) as necessary for complete installation.

C. Network (IP) Cameras:
   1. Signal-to-Noise Ratio: Not less than 50 dB.
   2. Provide the following standard features:
      b. Automatic gain control.
      c. Automatic white balance.
      d. Web-based interface for remote viewing and setup.
      e. Password protected security access.
   3. Network (IP) Indoor Camera:
      a. Camera Type: True day/night with IR cut filter.
      b. Image Sensor: 1/4 inch CMOS.
      c. Resolution: Up to 1080P (1920 x 1080).
      d. Frame Rate: Up to 30 frames per second (fps) at all available resolutions.
      f. Power: Power over Ethernet (IEEE 802.3af) or 24 VAC as indicated or as required.

D. Lenses:
   1. Where not factory-installed, provide lenses matched to cameras and the intended application.

E. Camera Enclosures and Mounting Brackets:
   1. Where not factory-installed, provide accessory camera enclosures suitable for operation under the service conditions at the installed location.
   2. Where not factory-installed, provide accessory camera mounting brackets necessary for installation.

2.05 ACCESSORIES

A. Provide components as indicated or as required for connection of video surveillance system to devices and other systems indicated.
B. Provide network switches as required for network connections to system components.

C. Provide accessory controllers as indicated or as required for operator control.

D. Provide cables as indicated or as required for connections between system components.
   1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP), minimum Category 6, complying with Section 27 1005.

E. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3  EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.

B. Install products in accordance with manufacturer's instructions.

C. Provide required support and attachment in accordance with Section 26 0529.

D. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
   1. Use suitable listed cables in wet locations, including underground raceways.
   2. Use suitable listed cables for vertical riser applications.
   3. Use listed plenum rated cables in spaces used for environmental air.
   4. Install wiring in conduit for the following:
      a. Where required for rough-in.
      b. Where required by authorities having jurisdiction.
      c. Where exposed to damage.
      d. Where installed outside the building.
      e. For exposed connections from outlet boxes to cameras.
   5. Conduit: Comply with Section 26 0533.13.
   6. Conceal all cables unless specifically indicated to be exposed.
7. Cables in the following areas may be exposed, unless otherwise indicated:
   a. Equipment closets.
   b. Within joists in areas with no ceiling.
8. Route exposed cables parallel or perpendicular to building structural members and surfaces.
9. Include service loop cable lengths to allow relocation of cameras within 30 ft of installed location.
E. Provide grounding and bonding in accordance with Section 26 0526.
F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
G. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Prepare and start system in accordance with manufacturer's instructions.
C. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.
D. Program system parameters according to requirements of Owner.
E. Test for proper interface with other systems.
F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES
A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four hours of training.
3. Location: At project site.

3.06 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.07 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of video surveillance system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:
   1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION
SECTION 28 46 00 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire alarm system design and installation, including all components, wiring, and conduit.
B. Transmitters for communication with supervising station.
C. Circuits from protected premises to supervising station, including conduit.
D. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.
E. Maintenance of fire alarm system under contract for specified warranty period.

1.02 SUMMARY

A. Provide a new, complete, operative, coordinated, and tested non-coded, intelligent addressable fire detection and alarm system in accordance with the Specifications and Drawings.
B. Drawings indicating fire alarm devices, locations and quantities are diagrammatic in character and do not necessarily indicate every required piece of equipment and device. Items not specifically mentioned in the specification or noted on the Drawings, but which are necessary to make a complete working installation in accordance with code requirements of the Authority Having Jurisdiction shall be included.
C. Contractor shall provide fully engineered fire alarm shop drawings for review by the local building and fire department. the fire alarm shop drawings shall be signed and sealed by a registered professional engineer in the project's state.

1.03 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping: Materials and methods for work to be performed by this installer.
B. Section 08 33 23 - Overhead Coiling Doors: Coiling fire doors to be released by fire alarm system.
C. Section 08 71 00 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
D. Section 14 21 00 - Electric Traction Elevators: Elevator systems monitored and controlled by fire alarm system.
E. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.

F. Section 21 30 00 - Fire Pumps: Supervisory devices.

G. Section 23 33 00 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.04 REFERENCE STANDARDS


C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.


1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Proposal Documents: Submit the following with cost/time proposal:
   1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
   2. Manufacturer’s detailed data sheet for each control unit, initiating device, and notification appliance.
   3. Certification by Contractor that the system design will comply with the contract documents.

C. Drawings must be prepared using AutoCAD Release 2103 or newer.
   1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.

D. Evidence of designer qualifications.

E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
   1. Design documents shall be "wet sealed" and "signed" by a registered professional engineer in the state in which the system is being installed.
   2. Copy (if any) of list of data required by authority having jurisdiction.
   3. NFPA 72 "Record of Completion", filled out to the extent known at the time.
   4. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
5. System zone boundaries and interfaces to fire safety systems.
6. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
7. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
8. List of all devices on each signaling line circuit, with spare capacity indicated.
9. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
10. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
11. Detailed drawing of graphic annunciator(s).
12. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
13. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
14. Certification by Contractor that the system design complies with the contract documents.
15. Do not show existing components to be removed.

F. Evidence of installer qualifications.

G. Evidence of instructor qualifications; training lesson plan outline.

H. Evidence of maintenance contractor qualifications, if different from installer.

I. Inspection and Test Reports:
   1. Submit inspection and test plan prior to closeout demonstration.
   2. Submit documentation of satisfactory inspections and tests.
   3. Submit NFPA 72 "Inspection and Test Form," filled out.

J. Operating and Maintenance Data: See Section 01 78 00 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
   1. Complete set of specified design documents, as approved by authority having jurisdiction.
   2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
   3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
   4. List of recommended spare parts, tools, and instruments for testing.
   5. Replacement parts list with current prices, and source of supply.
   6. Detailed troubleshooting guide and large scale input/output matrix.
   7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
   8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
K. Project Record Documents: See Section 01 78 00 for additional requirements; have one set available during closeout demonstration:
   1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
   2. "As installed" wiring and schematic diagrams, with final terminal identifications.
   3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

L. Closeout Documents:
   1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
   2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.

M. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
   3. In addition to the items in quantities indicated in PART 2, furnish the following:
      a. One copy, on CD-ROM, of all software not resident in read-only-memory.
      b. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.06 QUALITY ASSURANCE

A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.

B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
   1. Designer shall be a registered Professional Engineer in the State in which the project is installed.

C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
   1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
   2. Installer Personnel: At least 2 years of experience installing fire alarm systems.

D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
E. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.

C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Alarm Control Units: Provided their products meet or exceed the performance of the basis of design product, products of the following are acceptable:


7. Provide control units made by the same manufacturer.

B. Initiating Devices and Notification Appliances:


7. Same manufacturer as control units.

8. Provide initiating devices and notification appliances made by the same manufacturer, where possible.
2.02 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
   1. Provide all components necessary, regardless of whether shown in the contract documents or not.
   2. Protected Premises: Entire building shown on drawings.
   3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
      a. ADA Standards.
      b. The requirements of the State Fire Marshal.
      c. The requirements of the local authority having jurisdiction.
      d. Applicable local codes.
      e. The contract documents (drawings and specifications).
      f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
   4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
   6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
   7. Program notification zones and voice messages as directed by Owner.
   8. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
   9. Fire Command Center: Location indicated on drawings.
  10. Fire Alarm Control Unit: New, located at fire command center.

B. Supervising Stations and Fire Department Connections:
   1. Public Fire Department Notification: By new auxiliary fire alarm system approved by authority having jurisdiction.
   2. Auxiliary Connection Type: Local energy.
   3. Provide dedicated phone line in 3/4"C. to FACP from building phone system location for monitoring.

C. Circuits:
   1. Initiating Device Circuits (IDC): Class B, Style A.
   2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
   4. Notification Appliance Circuits (NAC): Class B, Style W.

D. Spare Capacity:
   1. Initiating Device Circuits: Minimum 25 percent spare capacity.
   4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
a. Where installed in core/shell buildings intended for future tenants space buildout, provide sufficient capacity for buildout of future tenant spaces.

E. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.03 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.
2. Dry-pipe sprinkler system pressure.
3. Dry-pipe sprinkler valve room low temperature.
4. Fire pump(s).
5. Elevator shut-down control circuits.

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
2. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
3. Duct smoke detectors.

C. Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters’ service.
2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.
4. Elevator Door Smoke Curtains: Release upon activation of smoke detectors in smoke zone, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 34 77.

D. HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.

E. Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 71 00.
   a. Provide 120V circuits and connections as required. Coordinate with door hardware.
2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 08 71 00.
   a. Provide 120V circuits and connections as required. Coordinate with door hardware.
3. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 33 23.

2.04 COMPONENTS

A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Conduit and Raceway system:
1. Provide a complete metal raceway system for fire alarm and detection wiring.
   a. Conduit are 3/4 inch minimum. Conduit fill are not to exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
2. Paint fire detection and alarm system junction boxes and covers red.

C. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

D. Master Control Unit: As specified for Basis of Design above, or equivalent.

E. Remote Annunciators: ________.

F. Initiating Devices:
   1. Addressable Systems:
      a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
      b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
      a. Provide 10% extra.
      b. Provide covers for Manual Pull Stations in areas where it is necessary to deter unwanted activation, or guard against physical damage or vandalism.
   3. Key Operated Pull Stations: ________.
      a. Provide 10% extra.
   4. Smoke Detectors: ________.
      a. Provide 10% extra.
      b. Provide covers for Smoke Detectors in areas where it is necessary to guard against physical damage or vandalism.
   5. Duct Smoke Detectors: ________.
      a. Provide 10% extra.
   6. Heat Detectors: ________.
      a. Provide 10% extra.
      b. Provide covers for Thermal Detectors in areas where it is necessary to guard against physical damage or vandalism.
   7. Addressable Interface Devices: ________.
      a. Provide 10% extra.
G. Notification Appliances:
1. Bells: _______.
   a. Provide 10% extra.
2. Speakers: _______.
   a. Provide 10% extra.
3. Strobes: _______.
   a. Provide 10% extra.

H. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

I. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.

J. Locks and Keys: Deliver keys to Owner.
1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type.

K. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
2. Provide one for each control unit where operations are to be performed.
3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
4. Provide extra copy with operation and maintenance data submittal.

L. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.
1. Padlock eye and hasp for lock furnished by Owner.
2. Locate as directed by Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.

B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

C. Obtain Owner's approval of locations of devices, before installation.

D. Install instruction cards and labels.
3.02 INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.

B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.

D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.

E. Provide all tools, software, and supplies required to accomplish inspection and testing.

F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.

G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
   1. Record all system operations and malfunctions.
   2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
   3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
   4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 Owner PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:
   2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.

B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
   1. Initial Training: 1 session pre-closeout.

C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
   1. Initial Training: 1 session pre-closeout.

D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.04 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
1. Be prepared to conduct any of the required tests.
2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
3. Have authorized technical representative of control unit manufacturer present during demonstration.
4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
5. Repeat demonstration until successful.

B. Occupancy of the project will not occur prior to Substantial Completion.

C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
1. Specified diagnostic period without malfunction has been completed.
2. Approved operating and maintenance data has been delivered.
3. Spare parts, extra materials, and tools have been delivered.
4. All aspects of operation have been demonstrated to Owner.
5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
6. Specified pre-closeout instruction is complete.

3.05 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, a proposal as an alternate to the base bid, for a maintenance contract for entire warranty period, to include the work described below; include the total cost of contract, proposal to be valid at least until 30 days after date of Substantial Completion.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

G. Comply with Owner's requirements for access to facility and security.

END OF SECTION
SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Protecting existing vegetation to remain.
   2. Removing existing vegetation.
   3. Clearing and grubbing.
   4. Stripping and stockpiling topsoil.
   5. Stripping and stockpiling rock.
   6. Removing above- and below-grade site improvements.
   7. Disconnecting, capping or sealing, and [removing site utilities] [abandoning site
      utilities in place].
   8. Temporary erosion and sedimentation control.

B. Related Requirements:
   1. Section 01 50 00 "Temporary Facilities and Controls" for temporary erosion- and
      sedimentation-control measures.

1.02 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a
   naturally occurring soil profile, typified by less than 1 percent organic matter and few
   soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In
   undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such
   as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or
   existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or
   existing in-place surface soil; the zone where plant roots grow. Its appearance is
   generally friable, pervious, and black or a darker shade of brown, gray, or red than
   underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects
   larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other
   nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or
   other vegetation to be protected during construction and indicated on Drawings.
F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and [indicated on Drawings] [indicated according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection.”] <Insert requirement>.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.04 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.05 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.06 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.
1.07 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner’s property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner’s premises where indicated.

D. Utility Locator Service: Notify Call Before You Dig, One Call for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.
B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.03 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.04 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
   1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.
   2. Owner will arrange to shut off indicated utilities when requested by Contractor.
C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect’s written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 02 41 16 “Structure Demolition” and Section 02 41 19 “Selective Demolition.”

3.05 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 8 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.06 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
3.07 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.08 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00
SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade walks pavements turf and grasses and plants.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks pavements.
6. Subbase course and base course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.
9. Excavating well hole to accommodate elevator-cylinder assembly.

B. Related Requirements:

1. Section 01 32 00 "Construction Progress Documentation" Section 01 32 33 "Photographic Documentation" for recording preexcavation and earth-moving progress.
2. Section 03 30 00 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
3. Section 31 10 00 "Site Clearing" for site stripping, grubbing, stripping topsoil, and removal of above- and below-grade improvements and utilities.
4. Section 31 23 19 "Dewatering" for lowering and disposing of ground water during construction.
5. Section 31 50 00 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
6. Section 31 63 29 "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.
7. Section 32 92 00 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
8. Section 32 93 00 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.02 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 01 22 00 "Unit Prices."

B. Quantity allowances for earth moving are included in Section 01 21 00 "Allowances."
1.03 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including
      haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench
   before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes
   upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines
   and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or
      beyond indicated lines and dimensions as directed by Architect. Authorized additional
      excavation and replacement material will be paid for according to Contract provisions for
      changes in the Work.
   2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in
      length.
   3. Unauthorized Excavation: Excavation below subgrade elevations or beyond
      indicated lines and dimensions without direction by Architect. Unauthorized
      excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs,
   mechanical and electrical appurtenances, or other man-made stationary features
   constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for
   hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a
   cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill
   immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as
   underground services within buildings.
1.04 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct preexcavation conference at Project site.
      1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
         a. Personnel and equipment needed to make progress and avoid delays.
         b. Coordination of Work with utility locator service.
         c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
         d. Extent of trenching by hand or with air spade.
         e. Field quality control.

1.05 ACTION SUBMITTALS
   A. Product Data: For each type of the following manufactured products required:
      1. Geotextiles.
      2. Controlled low-strength material, including design mixture.
      3. Geofoam.
      4. Warning tapes.
   B. Samples for Verification: For the following products, in sizes indicated below:
      2. Warning Tape: 12 inches long; of each color.

1.06 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified testing agency.
   B. Material Test Reports: For each soil material proposed for fill and backfill as follows:
   C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.07 FIELD CONDITIONS
   A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
      1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
      2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify "Call Before You Dig", "One Call" for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion-and sedimentation-control measures specified in Section 01 50 00 "Temporary Facilities and Controls" and Section 31 10 00 "Site Clearing" are in place.

E. Do not commence earth-moving operations until plant-protection measures specified in Section 01 56 39 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145; free of rock or gravel larger than [3 inches] in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M O; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

G. Drainage Course: Narrowly graded mixture of [washed ]crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

I. Sand: ASTM C 33/C 33M; fine aggregate.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.02 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Survivability: As follows:
   a. Grab Tensile Strength: 157 lbf; ASTM D 4632.
   b. Sewn Seam Strength: 142 lbf; ASTM D 4632.
   c. Tear Strength: 56 lbf; ASTM D 4533.
   d. Puncture Strength: 56 lbf; ASTM D 4833.
3. Apparent Opening Size: [No. 40] [No. 60] [No. 70] sieve, maximum; ASTM D 4751.
4. Permittivity: [0.5] [0.2] [0.1] per second, minimum; ASTM D 4491.
5. UV Stability: 50 percent after 500 hours’ exposure; ASTM D 4355.
B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Survivability: As follows:
   a. Grab Tensile Strength: 247 lbf; ASTM D 4632.
   b. Sewn Seam Strength: 222 lbf; ASTM D 4632.
   c. Tear Strength: 90 lbf; ASTM D 4533.
   d. Puncture Strength: 90 lbf; ASTM D 4833.
3. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
4. Permittivity: 0.02 per second, minimum; ASTM D 4491.
5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.03 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, flowable concrete material produced from the following:

1. Portland Cement: ASTM C 150/C 150M, [Type I] [Type II] [or] [Type III].
2. Fly Ash: ASTM C 618, Class C or F.
4. Foaming Agent: ASTM C 869/C 869M.
5. Water: ASTM C 94/C 94M.

B. Produce low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: [30 to 36 lb/cu. ft.] [36 to 42 lb/cu. ft.] <Insert unit weight range> at point of placement, when tested according to ASTM C 138/C 138M.
2. Compressive Strength: [80 psi] [140 psi] <Insert value>, when tested according to ASTM C 495/C 495M.

C. Produce conventional-weight, controlled low-strength material with [80-psi] [140-psi] <Insert value> compressive strength when tested according to ASTM C 495/C 495M.

2.04 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
   a. [24 inches outside of concrete forms other than at footings.
   b. 12 inches outside of concrete forms at footings.
   c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

3.04 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.05 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.
3.06 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: As indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
   2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
   3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
   4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:
   1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
   3. Cut and protect roots according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.07 EXCAVATION FOR ELEVATOR CYLINDER

A. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in Section 14 24 00 "Hydraulic Elevators."
B. Provide well casing as necessary to retain walls of well hole.

3.08 SUBGRADE INSPECTION
A. Notify Architect when excavations have reached required subgrade.
B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Completely proof-roll subgrade in one direction repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
   2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.09 UNAUTHORIZED EXCAVATION
A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 BACKFILL
A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
   
   a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
3.12 **SOIL FILL**

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 **SOIL MOISTURE CONTROL**

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 **COMPACTION OF SOIL BACKFILLS AND FILLS**

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to [ASTM D 698] [ASTM D 1557]:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
   3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
   4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.
3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.
   2. Walks: Plus or minus 1 inch.
   3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Section 33 46 00 "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
   1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
   1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
   2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to [ASTM D 698] [ASTM D 1557].

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to [ASTM D 698] [ASTM D 1557].

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
4. <Insert special inspections>.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:
   1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
   3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00
SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt patching.
   2. Hot-mix asphalt paving.

B. Related Requirements:
   1. Section 02 41 16 "Structure Demolition" and Section 02 41 19 "Selective Demolition" for demolition and removal of existing asphalt pavement.
   2. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
   3. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.02 UNIT PRICES

A. Work of this Section is affected by ton of asphalt.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

   1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

      a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
      b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include technical data and tested physical and performance properties.
   2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

B. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:
1. Paving Fabric: 12 by 12 inches minimum.

1.05 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

B. Material Test Reports: For each paving material, by a qualified testing agency.

C. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

1.07 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.01 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: [ASTM D 1073] [or] [AASHTO M 29], sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: [ASTM D 242/D 242M] [or] [AASHTO M 17], rock or slag dust, hydraulic cement, or other inert material.

2.02 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22.

B. Asphalt Cement: [ASTM D 3381/D 3381M for viscosity-graded material] [ASTM D 946/D 946M for penetration-graded material].

C. Cutback Prime Coat: ASTM D 2027, medium-curing cutback asphalt, [MC-30 or MC-70] [MC-250].

D. Emulsified Asphalt Prime Coat: [ASTM D 977] [or] [AASHTO M 140] emulsified asphalt, or [ASTM D 2397] [or] [AASHTO M 208] cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Tack Coat: [ASTM D 977] [or] [AASHTO M 140] emulsified asphalt, or [ASTM D 2397] [or] [AASHTO M 208] cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Water: Potable.

G. Undersealing Asphalt: ASTM D 3141/D 3141M; pumping consistency.

2.03 AUXILIARY MATERIALS

A. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

B. Joint Sealant: ASTM D 6690Type II, hot-applied, single-component, polymer-modified bituminous sealant.

2.04 MIXES

1. 

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes; designed according to procedures in AIM S-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: S (75) PG 64-22
3. Surface Course: SX (75) PG 64-22.
C. Emulsified-Asphalt Slurry: ASTM D 3910, Type 2.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

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

3.02 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.
E. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.03 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.04 PAVING GEOTEXTILE INSTALLATION

A. Apply tack coat asphalt binder asphalt cement uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd..

B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.

C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

3.05 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.

2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.06 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.07 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.
D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.08 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F.

1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.09 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Asphalt Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch of height indicated above pavement surface.
3.10 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.

   1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to [ASTM D 979] [or] [AASHTO T 168].

   1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

   2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

      a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.

      b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 01 74 19 "Construction Waste Management and Disposal."

END OF SECTION 321216

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SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

A. Section Includes Concrete Paving Including the Following:
   1. Parking lots.
   2. Curbs and gutters.
   3. Walks.

B. Related Requirements:
   1. Section 03 30 00 "Cast-in-Place Concrete" Section 03 30 53 "Miscellaneous Cast-in-Place Concrete" for general building applications of concrete.
   2. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.02 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to concrete paving, including but not limited to, the following:
      a. Concrete mixture design.
      b. Quality control of concrete materials and concrete paving construction practices.
   2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Concrete paving Subcontractor.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

1. Exposed Aggregate: 10-lb Sample of each mix.

C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
1.07 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.08 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms[, steel reinforcement,] and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.02 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.03 STEEL REINFORCEMENT

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

C. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

D. Tie Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI’s "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

G. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

2.04 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150/C 150M, grayportland cement Type II.
2. Fly Ash: ASTM C 618, [Class C] [or] [Class F].

B. Normal-Weight Aggregates: ASTM C 33/C 33M, [Class 4S] [Class 4M] [Class 1N] <Insert class>, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch to 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: Potable and complying with ASTM C 94/C 94M.

2.05 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

B. Water: Potable.

C. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. **Products**: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. [Anti-Hydro International, Inc.](#); A-H Curing Compound #2 DR WB.
   b. [ChemMasters, Inc.](#); Safe-Cure Clear DR.
   c. [Dayton Superior Corporation](#); Clear Resin Cure J11W.
   d. [Euclid Chemical Company (The), an RPM company](#); Kurez DR VOX.
   e. [Kaufman Products, Inc.](#); DR Cure.
   f. [L&M Construction Chemicals, Inc.](#); L&M Cure R.
   g. [Lambert Corporation](#); Aqua Kure - Clear.
   h. [Meadows, W. R., Inc.](#); 1100-CLEAR.
   i. [Nox-Crete Products Group](#); Res-Cure DH DS.
   j. [Right Pointe](#); Clear Water Resin.
   k. [SpecChem, LLC](#); PaveCure Rez.
   l. [TK Products, Division of Sierra Corporation](#); TK-2519 DC WB.
   m. [Vexcon Chemicals Inc.](#); Certi-Vex Envio Cure 100.

D. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

1. **Products**: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

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CONCRETE PAVING
a. Anti-Hydro International, Inc.; A-H Curing Compound #2 WP WB.
c. Dayton Superior Corporation; White Resin Cure J10W.
e. L&M Construction Chemicals, Inc.; L&M Cure R-2.
f. Lambert Corporation; Aqua-Cure - White.
g. Meadows, W. R., Inc.; 1200-WHITE.
h. SpecChem, LLC; PaveCure Rez White.
i. Vexcon Chemicals Inc.; Certi-Vex Envio Cure White 100.
j. Insert manufacturer’s name; product name or designation.

2.06 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber ASTM D 1752, cork or self-expanding cork in preformed strips.

2.07 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Use fly ash or pozzolan as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.

C. Add air-entraining admixture at manufacturer’s prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 6-1/2 percent plus or minus 1-1/2 percent for 3/4-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer’s written instructions.

1. Use water-reducing admixture high-range, water-reducing admixture high-range, water-reducing and retarding admixture plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
F. Concrete Mixtures: Normal-weight concrete.

2. Maximum W/C Ratio at Point of Placement: 0.45.
3. Slump Limit: 2-1/2 inches, plus or minus 1-1/2 inches.

2.08 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction[ and repeat in perpendicular direction]. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting according to requirements in Section 31 20 00 "Earth Moving."

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

3.02 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's “Manual of Standard Practice” for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.05 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.

2. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete paving:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
   a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels joint devices.
H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.07 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.08 DETECTABLE WARNING INSTALLATION

A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 32 17 26 "Tactile Warning Surfacing."

1. Tolerance for Opening Size: Plus 1/4 inch, no minus.

3.09 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by curing compound as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
3. Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
   a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13
SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY
A. Section Includes:
   1. Cold-applied joint sealants.
   2. Hot-applied joint sealants.
   4. Primers.

B. Related Requirements:
   1. Section 07 92 00 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.02 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
C. Paving-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

1.04 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Product Certificates: For each type of joint sealant and accessory.
1.05 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1.06 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.02 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I, II, or III.

   1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

      a. Crafo Inc.; RoadSaver 222.
      c. Right Pointe; JTS 3405 Regular 003 JTS 3405 Rubber 009.

2.03 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
2.04 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.02 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.04 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.05 PAVING-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within concrete paving[ PJS-#1.

1. Joint Location:
   a. Expansion and isolation joints in concrete paving.
   b. Contraction joints in concrete paving.
   c. Other joints as indicated.

B. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving [PJS-#2].

1. Joint Location:
   a. Joints between concrete and asphalt paving.
   b. Joints between concrete curbs and asphalt paving.
   c. Other joints as indicated.


END OF SECTION 32 13 73
SECTION 32 17 13 - PARKING BUMPERS

PART 1 - GENERAL

1.01 SUMMARY
   A. Section includes wheel stops.

1.02 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples for Initial Selection: For each type of exposed finish requiring color selection.

PART 2 - PRODUCTS

2.01 PARKING BUMPERS
   A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed vertical holes through wheel stop for anchoring to substrate.
      1. Surface Appearance: Free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
      2. Mounting Hardware: Galvanized-steel spike or dowel, 1/2-inch diameter, 10-inch minimum length.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Verify that pavement is in suitable condition to begin installation according to manufacturer’s written instructions.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION
   A. General: Install wheel stops according to manufacturer’s written instructions unless otherwise indicated.
B. Install wheel stops in bed of adhesive before anchoring.

C. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION 32 17 13
SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes painted markings applied to asphalt and concrete pavement.

B. Related Requirements:
   1. Section 09 91 13 "Exterior Painting" for painting exterior concrete surfaces other than pavement.
   2. Section 09 91 23 "Interior Painting" for painting interior concrete surfaces other than pavement.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to marking pavement including, but not limited to, the following:
      a. Pavement aging period before application of pavement markings.
      b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include technical data and tested physical and performance properties.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.2: For interior, field-applied, pavement-marking paints, documentation including printed statement of VOC content.

C. Shop Drawings: For pavement markings.
   1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
   2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

D. Samples: For each exposed product and for each color and texture specified; on rigid backing, 8 inches square.
1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of for pavement-marking work.

   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.05 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, or comparable product by one of the following:

1. Aexcel Inc.
2. Benjamin Moore & Co.
5. Conco Paints.
6. Coronado Paint; Division of INSL-X Products Corporation.
10. Frazee Paint.
11. General Paint.
15. Miller Paint.
17. PPG Industries.
18. Pratt & Lambert.
20. Rohm and Haas Company; a subsidiary of The Dow Chemical Company.
22. Sherwin-Williams Company (The).
23. <Insert manufacturer's name>.
2.02 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
   1. Color: As indicated.

B. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.
   1. Color: As indicated.

C. Glass Beads: AASHTO M 247, Type 1.
   1. Roundness: Minimum 80 percent true spheres by weight.

D. VOC Content: Pavement markings used on building interior shall have a VOC content of 150 g/L or less.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer’s written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.02 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer’s recommended rates to provide a minimum wet film thickness of 15 mils.
   1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.
   2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.
3.03 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 32 17 23
SECTION 32 17 26 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Detectable warning unit pavers.

B. Related Requirements:
   1. Section 32 14 00 "Unit Paving" for unit paving installations incorporating detectable warning unit pavers specified in this Section.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.04 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.05 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.06 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Mortar and Grout:

2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set unit pavers within 1 minute of spreading setting-bed mortar.

1.07 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering and wear.

b. Separation or delamination of materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Regional Materials: Detectable warning unit pavers shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Source Limitations: Obtain each type of tactile warning surfacing, setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
2.02 DETECTABLE WARNING UNIT PAVERS

A. Detectable Warning Concrete Unit Pavers: Solid paving units, made from normal-weight concrete with a compressive strength of not less than 5000 psi, water absorption of not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67, with accessible detectable warning truncated domes on exposed surface of units.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Advanced Surface Systems, LLC.
   b. ECG, Inc.; a division of Elizabeth City Glass Co.
   c. Engineered Plastics, Inc.; Armor-Tile.
   d. Hanover Architectural Products.
   e. Tile-Tech Pavers.
   f. <Insert manufacturer's name>.

3. Shapes and Sizes:
   a. Thickness: 2-1/2 inches at field of tile.
   b. Face Size: Nominal 24 by 24 inches.


5. Color: As indicated by manufacturer's designations As selected by Architect from manufacturer's full range.

B. Setting Bed: Comply with requirements in Section 32 14 00 "Unit Paving."

C. Aggregate Setting Bed:

   2. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate.
   3. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

D. Mortar Setting Bed:

   1. Portland Cement: ASTM C 150/C 150M, Type I or Type II.
   2. Sand: ASTM C 33/C 33M.
3. Latex Additive: Manufacturer’s standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.


PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

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

3.02 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.03 INSTALLATION OF DETECTABLE WARNING TILES

3.04 INSTALLATION OF DETECTABLE WARNING UNIT PAVERS

A. Unit Paver Installation, General:

1. Setting-Bed and Unit Paver Installation: Comply with installation requirements in Section 32 14 00 “Unit Paving.”

2. Mix unit pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

3. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.

4. Tolerances: Do not exceed 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

B. Aggregate Setting-Bed Applications:

1. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.
2. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until unit pavers are set and compacted.
3. Treat leveling course with herbicide to inhibit growth of grass and weeds.
4. Set unit pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines.
5. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz.
6. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

C. Mortar Setting-Bed Applications:

1. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.
3. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
4. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
5. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- thick bond coat to mortar bed or to back of each paver with a flat trowel.
6. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
7. Spaced Joint Widths: Provide 3/8-inch nominal joint width with variations not exceeding plus or minus 1/8 inch.
8. Grouted Joints: Grout paver joints complying with ANSI A108.10. Grout joints as soon as possible after initial set of setting bed.
   a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
   b. Tool exposed joints slightly concave when thumbprint hard.
   c. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.
9. Remove excess grout from exposed paver surfaces; wash and scrub clean.
10. Protect installation from traffic until grout has set.
3.05 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 32 17 26
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes the following for fence type CLF-1:

   a. Steel wire with metallic coating with polymer color coat.

2. Chain-Link Fence Framework.
   a. Post Material:
      1) Heavy-industrial-strength Group IA or IC round steel pipe posts.
   b. Horizontal Members:
      1) Top rails.
      2) Bottom rails.
   c. Brace and truss rails.
   d. Coating:
      1) Metallic coating and polymer color coat.

3. Fittings.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for the following:
   a. Post footings.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.

B. Shop Drawings: For each type of fence and gate assembly.
   1. Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:
   1. Professional engineer.

B. Product Certificates: For each type of the following:
   1. Chain-link fence.

C. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by either of the following:
   1. Manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Mockups: Build mockups to set quality standards for fabrication and installation.
   1. Build mockup for the following:
      a. Typical chain-link fence, including accessories.
         1) Size: 10-foot length of fence.

1.06 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.
1.07  WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure to comply with performance requirements.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01  PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.

1. Design Wind Load: As indicated on Structural Drawings.
   a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed 10 feet for Material Group IA, ASTM F 1043, Schedule 40 steel pipe or Group IC, electric-resistance-welded round steel pipe.

2.02  CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire for Fabric.
   a. Mesh size and wire diameter as follows:
      1) 1-3/4 inches by 0.148 inch diameter.
   b. Polymer-Coating: Applied per ASTM F 668, Class 1 or Class 2a over metallic coated steel wire specified above.
1) Color: As selected by Architect from manufacturer's full range, according to ASTM F 934.

3. Selvage:
   a. Knuckled at both selvages.

2.03 FENCE FRAMEWORK

A. Light-Industrial-Strength Posts and Rails, Group IC-L: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
   1. Fence Height: As indicated on Drawings.

B. Heavy-Industrial-Strength Posts and Rails, Group IA or IC: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:
   1. Fence Height: As indicated on Drawings.

C. Coatings:
   1. Polymer Coating: Apply over metallic coating specified above.
      a. Color: As selected by Architect from manufacturer's full range, according to ASTM F 934.

2.04 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Post Caps: Provide for each post.
   1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Rail Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:
   1. Top Rail Sleeves: Not less than 6 inches long, fabricated from following:
      a. For Steel Rails: Pressed-steel or round-steel tubing.
   2. Rail Clamps: Line and corner boulevard clamps for connecting following to posts.
      a. Intermediate rails.
b. Bottom rails.

E. Tension and Brace Bands: Fabricated from following:

1. For Steel Framing: Pressed steel.

F. Tension Bars: Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

1. Length not less than 2 inches shorter than full height of chain-link fabric.
2. For Steel Framing: Fabricate tension bars from steel.

G. Truss Rod Assemblies: Metal rod and turnbuckle or other means of adjustment, fabricated from following:

1. For Steel Framing: Steel rod, hot-dip galvanized after threading.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

   a. Hot-Dip Galvanized Steel: 0.148-inch-diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

I. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

   a. Apply polymer color coating over metallic coating.

2.05 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.02 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Setting:

1. Posts Set in Concrete Footings: Set posts in concrete at indicated spacing into firm, undisturbed soil.

   a. Excavation: Drill or hand-excavate holes for posts. Excavate holes to a diameter of not less than 4 times posts size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.

   b. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete.

   c. Extend posts to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.

   d. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

1) Concealed Concrete: Place top of concrete 2 inches below grade to allow covering with surface material.
C. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

D. Line Posts: Space line posts uniformly at 96 inches o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

G. Bottom Rails: Secure to posts with fittings.

H. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

K. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

END OF SECTION 32 31 13
SECTION 32 31 16 - WELDED WIRE FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

2. Swing gates:
   a. Man gate, single leaf, manually operated.
3. Horizontal-slide gates:
   a. Vehicular gate cantilever slide, single leaf, motor operated.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for concrete bases for gate operators, drives, and controls and post concrete fill.
2. Section 28 13 00 "Access Control" for access control devices installed at gates and provided as part of a security system.
3. Section 31 20 00 "Earth Moving" for site excavation, fill, and backfill where welded-wire fences and gates are located.

1.02 DEFINITIONS

A. Metal Thicknesses: This Section specifies metal sheet thickness and wire diameter by nominal decimal inch or millimeter. Corresponding equivalent discontinued gage is indicated in following tables:

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<thead>
<tr>
<th>Metallic-Coated Steel Sheet</th>
<th>Steel Sheet Hot-dipped Galvanized After Fabrication</th>
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### NOMINAL STEEL WIRE THICKNESS

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1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
   2. Review sequence of operation for each type of gate operator.
   3. Review coordination of interlocked equipment specified in this Section and elsewhere.
   4. Review required testing, inspecting, and certifying procedures.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Gate operators, including operating instructions and motor characteristics.

B. Shop Drawings:
   1. For each type of fence assembly.
      a. Include accessories and hardware.
   2. For each type of gate assembly.
      a. Include plans, elevations, sections, details, and attachments to other work.
      b. Include accessories, hardware, gate operation, and operational clearances.
      c. Gate Operator:
         1) Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
         2) Wiring Diagrams: For power, signal, and control wiring.
1.05 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For gate operators to include in emergency, operation, maintenance manuals.

1.06 QUALITY ASSURANCE
A. Installer Qualifications: Fabricator of products.
B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.07 FIELD CONDITIONS
A. Field Measurements: Verify layout information for welded wire fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.08 WARRANTY
A. Special Warranty: Installer agrees to repair or replace components of welded wire fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   b. Faulty operation of gate operators and controls.

2. Warranty Period: As follows from date of substantial completion:
   a. Fences: 15 years.
   b. Gates: 15 years.
   c. Gate Operators: 5 years.

PART 2 - PRODUCTS

2.01 METALLIC-COATED-STEEL, WELDED-WIRE FENCES
A. Metallic-Coated-Steel, Welded-Wire Fences:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
B. Fence Fabric: Metallic-coated-steel wire.

C. Posts:
   1. Posts at Swing Man Gate Openings: In following size(s), thickness(es) and metals:
      a. Square tubes 3 by 3 inches formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.
   2. Posts at Cantilever Horizontal-Slide Vehicular Gates:
      a. Openings Wider Than 12 Feet: Square steel tubing, hot-dip galvanized, in following size(s) and thickness(es).
         1) 4 by 4 inches with 3/16-inch wall thickness.

D. Post Caps: Formed from steel sheet and hot-dip galvanized after forming.

E. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components.

F. Finish: Organic coating complying with requirements in ASTM F 2408.

2.02 SWING GATES

A. Man Gate, Single Leaf, Manually Operated:
   1. Gate Frame Height: As indicated.
   2. Gate Opening Width: As indicated.
   3. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes formed from 0.108-inch nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication. Outside dimensions as follows:
      a. Minimum 2 by 2 inches for frames and 1-1/2 by 1-1/2 inches for bracing.

5. Additional Rails: Provide as indicated, complying with requirements for fence rails.


7. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
   b. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

8. Rim Locks: BHMA A156.5, Grade 1, suitable for exterior use.
   a. Function: 621 - Latchbolt by key from outside and by turn from inside. Latchbolt is held retracted by device from inside.
   b. Material: Cast, forged, or extruded brass or bronze.
   c. Mounting Plate: Configuration necessary for mounting locks. Fabricate from 1/8-inch- thick, steel plate; hot-dip galvanize after fabrication.

9. Mortise Locks: BHMA A156.13, Grade 1, suitable for exterior use.
   a. Material: Brass or bronze.
   b. Levers: Cast, forged, or extruded brass or bronze.
   c. Mounting Box: Configuration necessary to enclose locks. Fabricate from 1/8-inch- thick, steel plate; hot-dip galvanize after fabrication.

10. Electric Strikes: BHMA A156.31, Grade 1, of configuration required for use with lock specified, fail-secure, and suitable for exterior use.
    a. Mounting Plate: Configuration necessary for mounting electric strikes. Fabricate from 1/8-inch- thick, steel plate; hot-dip galvanize after fabrication.
    b. Mounting: Mortise into post.

11. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push pad actuating bar, suitable for exterior use.
    a. Function: 08 - Entrance by lever. Key locks or unlocks lever.
    b. Mounting Channel: Bent-plate channel formed from 1/8-inch- thick, steel plate; hot-dip galvanized after fabrication. Channel spans gate frame. Exit device is mounted on channel web, recessed between flanges, with flanges extending 1/8 inch beyond push pad surface.

12. Finish exposed welds to comply with NOMMA Guideline 1, Finish #4 - good-quality, uniform undressed weld with minimal splatter.

13. Metallic-Coated-Steel Finish: High-performance or powder coating.

2.03 HORIZONTAL-SLIDE GATES

A. Vehicular Gate Cantilever Slide, Single Leaf, Motor Operated:
1. Roller Assemblies: Internal type.
2. Gate Frame Height: 72 inches.
3. Gate Opening Width: As indicated.
4. Automated vehicular gates shall comply with ASTM F 2200, Class III.
5. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing.
   a. Frame Members: Square tubes 2-1/2 by 2-1/2 inches formed from 0.108-inch nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.
   b. Bracing Members: Square tubes 2-1/2 by 2-1/2 inches formed from 0.108-inch nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.
7. Additional Rails: Provide as indicated, complying with requirements for fence rails.
8. Infill: Comply with requirements for adjacent fence.
9. Hardware: Latches permitting operation from both sides of gate, locking devices hangers roller assemblies and stops fabricated from mill-finished, Grade 319 aluminum-alloy casting with stainless-steel fasteners. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
10. Finish exposed welds to comply with NOMMA Guideline 1, Finish #4 - good-quality, uniform undressed weld with minimal splatter.
11. Metallic-Coated-Steel Finish: High-performance or powder coating.
12. Gate Operators:
   a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      1) Amazing Gates of America LLC.
      2) Apollo Gate Operators.
      3) AutoGate, Inc.
      4) Begley Automated Gate Systems.
      5) Byan Systems, Inc.
      6) CAME Americas Automation LLC.
      7) Chamberlain Group, Inc. (The).
      8) DoorKing, Inc.
      9) Eagle Access Control Systems, Inc.
      10) FAAC USA.
      11) Gates That Open, LLC.
      13) Tymetal Corp.
      14) US Automatic Inc.
   b. See Article "Gate Operators, General" below for general requirements for gate operators and motors.
c. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.

d. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

1) High Voltage Motor: 120 V.
   a) Horsepower: Not less than 3/4.
   b) Enclosure: Totally enclosed.
   c) Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
   d) Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
   e) Phase: One.

e. Gate Operator Mounting:

1) On cast-in-place concrete base.

f. Gate Operator Type:

1) Hydraulic:
   a) Duty: Heavy duty, commercial/industrial.
   b) Gate Speed: Minimum 45 feet per minute.
   c) Maximum Gate Weight: 800 lb.
   d) Frequency of Use: Continuous duty.
   e) Operating Type: Wheel-and-rail drive with manual release.
   f) Hydraulic Fluid: Of viscosity required for gate operation at ambient temperature range for Project.
   g) Locking: Hydraulic in both directions.
   h) Heater: Manufacturer's standard track and roller heater with thermostatic control.

g. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 enclosure for pedestal mounting, and with space for additional optional equipment. Provide the following remote-control device(s):

1) Control Station, Type:
   a) Keyed, three-position switch with open, stop, and close function; located remotely from gate. Provide two keys per station.

2) Card Reader: Functions only when authorized card is presented. Programmable, multiple -code system; face-lighted unit fully visible at night.
a) Reader Type: Proximity.
b) Features: Capable of monitoring and auditing gate activity.

h. Vehicle Detector(s):

1) Loop Detector: System includes automatic closing timer with adjustable time delay, timer cutoff switch, and loop detector designed to hold gate open until traffic clears. System includes electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. System includes number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement, as recommended in writing by detection system manufacturer for function indicated, at location shown on Drawings.

i. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1) Action: Reverse gate in both opening and closing cycles, and hold until clear of obstruction.

2) Internal Sensor: Built-in torque or current monitor senses gate is obstructed.

3) Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using gate edge transmitter and operator receiver system.

a) Along entire gate leaf leading edge.

4) Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

j. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

k. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.

1) Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge.

l. Operating Features:
1) Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.

2) Automatic Closing Timer: With adjustable time delay before closing and timer cutoff switch.

3) Clock Timer: Seven-day programmable for regular events.

m. Accessories:

1) Fire box.
2) Instructional, Safety, and Warning Labels and Signs: According to UL 325.

2.04 GATE OPERATORS, GENERAL

A. Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide operator with UL approval.
4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.

B. Comply with NFPA 70.

C. UL Standard: Manufacturer and label gate operators to comply with UL 325.

2.05 FENCE AND GATE MATERIALS

A. Metallic-Coated-Steel Wire: Welded-wire fence fabric, hot-dip galvanized after fabrication. Weight of zinc coating shall be not less than 1.0 oz./sq. ft..

B. Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

D. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A 1011/A 1011M, Structural Steel, Grade 45.

1. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior.
E. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc, alloy-coated steel sheet.

F. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 50, with [G90] [G60] coating.

G. Aluminum-Zinc, Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50, with AZ60 coating.

H. Iron Castings: Either gray or malleable iron unless otherwise indicated.
   2. Malleable Iron: ASTM A 47/A 47M.

I. Galvanizing: For components indicated to be galvanized and for which galvanized coating is unspecified, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

2.06 COATING MATERIALS

A. Epoxy Primer for Galvanized Steel: Epoxy primer recommended in writing by topcoat manufacturer.

B. Polyurethane Intermediate Coat and Topcoat: Complying with MPI #72 and compatible with undercoat.

2.07 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size[ or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions].

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.08 METALLIC-COATED-STEEL FINISHES

A. Powder Coating:
1. **Surface Preparation:** Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a zinc-phosphate conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

2. Immediately after cleaning and pretreating, apply two-coat finish consisting of zinc-rich epoxy prime coat and TGIC polyester topcoat, with a minimum dry film thickness of 2 mils for topcoat. Comply with coating manufacturer's written instructions to achieve a minimum total dry film thickness of 4 mils.
   
   a. **Color and Gloss:** As selected by Architect from manufacturer's full range.
   
   b. Comply with surface finish testing requirements in ASTM F 2408.

**B. High-Performance Coating:**

1. **Surface Preparation:** Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a zinc-phosphate conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

2. Apply epoxy primer, polyurethane intermediate coat, and polyurethane topcoat to prepared surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
   
   a. **Color and Gloss:** As selected by Architect from manufacturer's full range.
   
   b. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

**C. Organic Coating:** Provide either powder coating or wet coating complying with ASTM F2408.

1. **Color and Gloss:** As selected by Architect from manufacturer's full range.

**PART 3 - EXECUTION**

**3.01 EXAMINATION**

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 01 73 00 "Execution."

3.03 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.04 GATE OPERATOR INSTALLATION

A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Settings and Excavation:

1. Hand-excavate depressions and holes in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated.

2. Cast-In-Place Concrete Bases: Depth 6 to 12 inches below frost line, dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings. See Section 03 30 00 "Cast-In-Place Concrete."

C. Vehicle Loop Detector System: Cut grooves in pavement and bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

D. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.05 ADJUSTING

A. Gates:

1. Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.

2. Confirm that latches and locks engage accurately and securely without forcing or binding.
3. Lubricate hardware and other moving parts.

B. Automatic Gate Operators:
   1. Energize circuits to electrical equipment and devices.
   2. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust operators, controls, safety devices, and limit switches.
   4. Hydraulic Operators: Purge operating system, adjust pressure and fluid levels, and check for leaks.
   5. Replace damaged and malfunctioning controls and equipment.

3.06 DEMONSTRATION AND TRAINING
   A. Train Owner’s personnel to adjust, operate, and maintain gates.

END OF SECTION 32 31 16
SECTION 32 31 21 - ARCHITECTURAL PRIVACY FENCE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Preformed, prefinished metal fence and flashings.
B. Miscellaneous trim, closures and accessories.
C. 16-gauge posts, 24-gauge studs, tracks, and blocking.
D. Fasteners.

1.02 RELATED SECTIONS

A. Section 03 30 00 "Cast-in-Place Concrete" for the following:
   1. Post footings

1.03 REFERENCES

A. American Iron & Steel Institute (AISI) Specification for the Design of Cold formed Steel Structural Members.
B. ASTM A-653 & ASTM A-924 Steel Sheet, Zinc-Coated (Galvanized)
C. Spec Data Sheet - Galvalume Sheet Metal by Bethlehem Corp.

1.04 ASSEMBLY DESCRIPTION

A. The manufacturer shall supply a total architectural steel fence system. The system shall include all components, including steel panels, flashing, posts, studs, track, blocking and fasteners.
B. The fence assembly shall include all preformed sheet metal panels, related accessories, caps, corners, ends, miscellaneous flashing and attaching devices.

1.05 SUBMITTALS

A. Submit detailed shop drawings showing layout of fence panels, anchoring details, joint details, trim, flashing, and accessories.
B. Submit a sample of each type of fence panel specified, including color chip of specified color.

C. Submit calculations with registered engineer seal, verifying fence panel and attachment method resists wind pressures imposed on it pursuant to applicable building codes.

1.06 QUALITY ASSURANCE

A. Manufacturer: Company specializing in Architectural Sheet Metal Products with ten (10) years minimum experience.

B. No product substitutions shall be permitted without meeting specifications.

C. Substitutions shall be submitted 10 Days prior to Bid Date and acceptance put forth in an addendum.

D. No substitutions shall be made after the Bid Date.

1.07 DELIVERY, STORAGE AND HANDLING

A. Upon receipt of panels and other materials, installer shall examine the shipment for damage and completeness.

B. Panels shall be stored in a clean, dry place. One end should be elevated to allow moisture to run off.

C. Panels with strippable film must not be stored in the open, exposed to the sun.

D. Stack all materials to prevent damage and to allow for adequate ventilation.

1.08 WARRANTY

A. Manufacturer shall provide twenty-year paint finish warranty against cracking, peeling and fading (not to exceed 5 N.B.S. units).

B. Installer shall provide warranty against defects of the installed fence system for the period of two (2) years from the date of substantial completion.

PART 2 - PRODUCTS

2.01 BASIS OF DESIGN MANUFACTURERS

A. The fence system shall conform to the Architectural Privacy Fence System by Berridge Manufacturing Company, San Antonio, Texas.
B. Substitutions shall fully comply with specified requirements.

2.02 SHEET MATERIALS

A. Prefinished Metal shall be prefinished Galvalume - ASTM 792-86 AZ-50 or Hot-Dipped Galvanized – ASTM A446-85 Grade C G90 Coating A525-86 24-gauge core steel.

B. Finish shall be full strength Kynar 500 Fluoropolymer coating applied by the manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.70 to 0.80 mil over 0.20 to 0.30 mil prime coat, to provide a total dry film thickness of 1.00 plus or minus 0.10mil. Bottom side shall be coated with primer with a dry film thickness of 0.30 plus or minus 0.05 mil. Finish shall conform to all tests for adhesion, flexibility, and longevity as specified by the Kynar 500 finish supplier.

C. Strippable film shall be applied to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. The strippable film must be removed before installation.

2.03 ACCESSORY MATERIALS

A. Concealed fasteners: Stainless Steel.

B. Where required exposed fasteners with washers painted to match finish of fence shall be required.

C. Concrete: ASTM C94/C94M, Option A, Portland Cement, minimum 2,500 psi (17 MPa) strength at 28 days.

D. Gates shall be framed separately using steel tubing and may be lined and trimmed with same panels and trim as the fencing system. Separate hinge posts should be used

2.04 FABRICATION

A. All exposed adjacent flashing shall be of the same material and finish as the fence panels.

B. Hem all exposed edges of flashing on underside, 1/2 inch.

C. Installation shall be governed by manufacturer’s installation instructions and details.

2.05 BERRIDGE CONCEALED FENCE PANEL

A. Vee-Panel: 12 3/4” coverage by 3/8” deep with smooth surface.

B. Standard post spacing shall be 10’-2 1/2” on center or as determined by local building code.
C. Standard height shall be 6'-0" with uniform ground clearance of 2".

PART 3 - EXECUTION

3.01 PREPARATION:

A. The grade shall be prepared and any surface irregularities removed, which may cause interference with the installation of the fence.

B. Holes shall be excavated for posts to diameter and spacing indicated on drawings and to suite local conditions for proper anchorage and stability.

3.02 FENCE INSTALLATION:

A. Installation shall be in accordance with manufacturer's instructions and details.

B. The installer shall provide all labor and materials necessary for installation of the steel fence system.

C. Posts shall be centered and aligned in excavated holes to proper depth.

D. Concrete shall be placed around posts and vibrated or tamped for consolidation.

E. Vertical and top alignment of posts shall be verified for plumb and true before concrete hardens.

3.03 CLEANING

A. Work area shall be left neat at end of each work day.

B. Excess earth from post hole excavations shall be removed from the site, or scattered uniformly away from posts, if earth is acceptable for pre-landscaping.

C. Any scratched surfaces shall be touched up with paint supplied by manufacturer, manufacturer's instructions included.

D. All scrap and construction debris shall be removed from the site.

END OF SECTION 32 31 21
SECTION 32 33 00 - SITE FURNISHINGS

PART 1 - GENERAL

1.01 SUMMARY
   A. Section Includes:
      1. Tables.
      2. Bicycle racks.

1.02 ACTION SUBMITTALS
   A. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

1.03 INFORMATIONAL SUBMITTALS
   A. Material Certificates: For site furnishings manufactured with preservative-treated wood.
      1. Indicate type of preservative used and net amount of preservative retained.

1.04 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 TABLES
   A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      1. DuMor Inc.
      2. Forms+Surfaces.
      3. Landscape Forms.
      4. Maglin Site Furniture Inc.
      5. Anova Furnishings.
   B. Frame: Steel .
   C. Table Top:
      1. Material:
a. Wood: Douglas fir; formed into planks.

2. Surface Shape: Shape indicated.

D. Steel Finish: Galvanized and color coated.

1. Color: As indicated by manufacturer's designation.

E. Wood Finish: Factory-applied stain and transparent finish.

1. Stain: Manufacturer's standard.

2.02 BICYCLE RACKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Forms+Surfaces.
2. DuMor Inc.
3. Landscape Forms.
4. Maglin Site Furniture Inc.
5. Anova Furnishings.

B. Bicycle Rack Construction:

1. Frame: Aluminum.
2. Style: Double-side parking.
   
a. Capacity: Designed to accommodate no fewer than two bicycles.

4. Installation Method: Surface flange anchored at finished grade to substrate indicated.

C. Aluminum Finish: Color coated.

1. Color: As selected by Architect from manufacturer's full range.

2.03 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.

E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

F. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.04 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

END OF SECTION 32 33 00
SECTION 32 84 00 - PLANTING IRRIGATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Piping.
   2. Automatic control valves.
   4. Quick couplers.
   5. Drip irrigation specialties.
   6. Controllers.

1.02 DEFINITIONS

A. Circuit Piping:  Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

B. Main Piping:  Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

C. Low Voltage:  As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.03 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with controller and automatic control valves.

B. Delegated Design:  Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.04 ACTION SUBMITTALS

A. Product Data:  For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams:  For power, signal, and control wiring.

C. Delegated-Design Submittal:  For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Irrigation systems, drawn to scale, on which components are shown and coordinated with each other, using input from Installers of the items involved. Also include adjustments necessary to avoid plantings and obstructions such as signs and light standards.

B. Qualification Data: For qualified Installer.

C. Zoning Chart: Show each irrigation zone and its control valve.

D. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.

E. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sprinklers controllers and automatic control valves to include in operation and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spray Sprinklers: Equal to 10 percent of amount installed for each type and size indicated, but no fewer than 15 units.

2. Bubblers: Equal to 10 percent of amount installed for each type indicated, but no fewer than 15 units.

3. Emitters: Equal to 10 percent of amount installed for each type indicated, but no fewer than 15 units.

4. Drip-Tube System Tubing: Equal to 10 percent of total length installed for each type and size indicated, but not less than 100 feet.

1.08 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers that include a certified irrigation designer qualified by The Irrigation Association.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
1.09 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.10 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 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 written permission.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedules 40 and 80.
   1. PVC Socket Fittings: ASTM D 2466, Schedules 40 and 80.
   2. PVC Threaded Fittings: ASTM D 2464, Schedule 80.
   3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.

2.02 PIPING JOINING MATERIALS

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

2.03 PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cash Acme; a division of The Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Honeywell International Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; Wilkins Water Control Products.

B. Water Control Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. CLA-VAL Automatic Control Valves.
   b. Flomatic Corporation.
   c. OCV Control Valves.
   d. Watts ACV; a division of Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; Wilkins Water Control Products.

2.04 AUTOMATIC CONTROL VALVES

A. Bronze, Automatic Control Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Buckner; a division of Storm Manufacturing Group Inc.
   b. Ceres Products Company.
   c. Champion Irrigation Products.
   d. Netafim USA.
   e. Superior Controls Co., Inc.
   f. Toro Company (The); Irrigation Division.
   g. Weathermatic.

2. Description: Cast-bronze body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

B. Plastic, Automatic Control Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Buckner; a division of Storm Manufacturing Group Inc.
   b. Ceres Products Company.
c. Champion Irrigation Products.
d. Dig Corporation.
e. Greenlawn Sprinkler Company.
f. Hit Products Corporation.
g. Hunter Industries Incorporated.
h. Irritrol Systems.
i. Nelson, L. R. Corporation.
j. Netafim USA.
k. Olson Irrigation Systems.
l. Orbit Irrigation Products, Inc.
m. Rain Bird Corporation.
n. Superior Controls Co., Inc.
o. Toro Company (The); Irrigation Division.
p. Weathermatic.

2. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

2.05 TRANSITION FITTINGS

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

2.06 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI WH 201, with bellows or piston-type pressurized cushioning chamber and in sizes complying with PDI WH 201, Sizes A to F.

B. Pressure Gages: ASME B40.1. Include 4-1/2-inch- diameter dial, dial range of two times system operating pressure, and bottom outlet.

2.07 SPRINKLERS

A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

B. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Buckner; a division of Storm Manufacturing Group Inc.
   b. Champion Irrigation Products.
   c. Hunter Industries Incorporated.
   d. Irritrol Systems.
   e. K-RAIN Manufacturing Corporation.
f. Nelson, L. R. Corporation.
g. Rain Bird Corporation.
h. Toro Company (The); Irrigation Division.
i. Weathermatic.

2. Description:

a. Body Material: ABS.
b. Nozzle: ABS.
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.

e. Pattern: Fixed, with flow adjustment.

C. Plastic, Pop-up Spray Sprinklers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Buckner; a division of Storm Manufacturing Group Inc.
b. Ceres Products Company.
c. Champion Irrigation Products.
d. Hit Products Corporation.
e. Hunter Industries Incorporated.
g. Nelson, L. R. Corporation.
h. Orbit Irrigation Products, Inc.
i. Rain Bird Corporation.
j. Toro Company (The); Irrigation Division.
k. Weathermatic.

2. Description:

a. Body Material: ABS.
b. Nozzle: ABS.
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.
e. Pattern: Fixed, with flow adjustment.

2.08 QUICK COUPLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Buckner; a division of Storm Manufacturing Group Inc.
2. Ceres Products Company.
3. Champion Irrigation Products.
7. Toro Company (The); Irrigation Division.
8. Weathermatic.

B. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.

2.09 DRIP IRRIGATION SPECIALTIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Agrifim.
2. Aquarius Brands, Inc.
3. Buckner; a division of Storm Manufacturing Group Inc.
4. Dig Corporation.
5. Geofflow, Inc.
8. Irritrol Systems.
9. Maxijet, Inc.
10. NDS/Raindrip.
11. Netafim USA.
13. Orbit Irrigation Products, Inc.
15. Roberts Irrigation Products, Inc.
17. Toro Company (The); Irrigation Division.

B. Freestanding Emitters: Device to deliver water at approximately 20 psig.

1. Body Material: PE or vinyl, with flow control.
2. Riser to Emitter: PE or PVC flexible tubing.
3. Capacities and Characteristics:
   a. Flow: 2 gph at approximately 20 psig.
   b. Tubing: PE or PVC; 1/8-inch minimum ID.

C. Drip Tubes with Direct-Attached Emitters:

1. Tubing: Flexible PE or PVC with plugged end.
2. Emitters: Devices to deliver water at approximately 20 psig.
   a. Body Material: PE or vinyl, with flow control.
   b. Mounting: Inserted into tubing at set intervals.

D. Off-Ground Supports: Plastic stakes.
E. Application Pressure Regulators: Brass or plastic housing, NPS 3/4, with corrosion-resistant internal parts; capable of controlling outlet pressure to approximately 20 psig.

F. Filter Units: Brass or plastic housing, with corrosion-resistant internal parts; of size and capacity required for devices downstream from unit.

G. Air Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.

H. Vacuum Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.

2.10 CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Buckner; a division of Storm Manufacturing Group Inc.
2. Champion Irrigation Products.
3. Hit Products Corporation.
5. Irritrol Systems.
8. Netafim USA.
9. Orbit Irrigation Products, Inc.
11. Superior Controls Co., Inc.
12. Toro Company (The); Irrigation Division.
13. Weathermatic.

B. Description:

1. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each station.
2. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof, with locking cover and [two] <Insert number> matching keys; include provision for grounding.
3. Control Transformer: 24-V secondary, with primary fuse.
4. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.
a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.
c. Surge Protection: Metal-oxide-varistor type on each station and primary power.

5. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.
6. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.
   a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
   b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
   c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

7. Concrete Base: Reinforced precast concrete not less than 36 by 24 by 4 inches thick, and 6 inches greater in each direction than overall dimensions of controller. Include opening for wiring.

2.11 BOXES FOR AUTOMATIC CONTROL VALVES

A. Plastic Boxes:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. Nationwide Plastics, Inc.
      d. NewBasis.
      e. Oldcastle, Inc.
      f. Orbit Irrigation Products, Inc.
      g. USFilter/Plymouth Products, Inc.
   2. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
      a. Size: As required for valves and service.
      b. Shape: Rectangular.
      c. Sidewall Material: PE, ABS, or FRP.
      d. Cover Material: PE, ABS, or FRP.
B. Polymer-Concrete Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation.
   d. Christy Concrete Products.
   e. NewBasis.
   f. Strongwell Corporation; Lenoir City Division.

2. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
   a. Size: As required for valves and service.
   b. Shape: Rectangular.
   c. Sidewall Material: Polymer concrete with lateral and vertical sidewall design loading of 5000 lb minimum over 10 by 10 inches square.
   d. Cover Material: Polymer concrete with cover design loading of 5000 lb minimum over 10 by 10 inches square.

C. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4 inch minimum to 3 inches maximum.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

B. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.

C. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3 inches, to 12 inches below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.

D. Provide minimum cover over top of underground piping according to the following:
   1. Irrigation Main Piping: Minimum depth of 36 inches below finished grade, or not less than 18 inches below average local frost depth, whichever is deeper.
   2. Circuit Piping: 12 inches.
3.02 PREPARATION
A. Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

3.03 PIPING INSTALLATION
A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.
C. Install piping free of sags and bends.
D. Install groups of pipes parallel to each other, spaced to permit valve servicing.
E. Install fittings for changes in direction and branch connections.
F. Install unions adjacent to valves and to final connections to other components with NPS 2 or smaller pipe connection.
G. Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 or larger pipe connection.
H. Install expansion loops in control-valve boxes for plastic piping.
I. Lay piping on solid subbase, uniformly sloped without humps or depressions.
J. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.
K. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install aboveground or in control-valve boxes.
L. Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.
M. Install piping in sleeves under parking lots, roadways, and sidewalks.
N. Install sleeves made of PVC pipe and socket fittings, and solvent-cemented joints.

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

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. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   3. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.05 SPRINKLER INSTALLATION
A. Install sprinklers after hydrostatic test is completed.
B. Install sprinklers at manufacturer’s recommended heights.
C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches from walls and 2 inches from other boundaries unless otherwise indicated.

3.06 DRIP IRRIGATION SPECIALTY INSTALLATION
A. Install freestanding emitters on pipe riser to mounting height indicated.
B. Install manifold emitter systems with tubing to emitters. Plug unused manifold outlets. Install emitters on off-ground supports at height indicated.
C. Install multiple-outlet emitter systems with tubing to outlets. Plug unused emitter outlets. Install outlets on off-ground supports at height indicated.
D. Install drip tubes with direct-attached emitters on ground.
E. Install drip tubes with remote-discharge on ground with outlets on off-ground supports at height indicated.
F. Install off-ground supports of length required for indicated mounted height of device.
3.07 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

A. Equipment Mounting: Install exterior freestanding controllers on precast concrete bases.

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.

B. Install control cable in same trench as irrigation piping and at least 2 inches below piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

3.08 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 13 "Facility Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.

C. Connect wiring between controllers and automatic control valves.

3.09 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.

1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Section 31 20 00 "Earth Moving" for warning tapes.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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. Test and adjust controls 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.

3.11 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.12 ADJUSTING

A. Adjust settings of controllers.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch above, finish grade.

3.13 CLEANING

A. Flush dirt and debris from piping before installing sprinklers and other devices.

3.14 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

3.15 PIPING SCHEDULE

A. Install components having pressure rating equal to or greater than system operating pressure.

B. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.
C. Underground irrigation main piping, NPS 4 and smaller, shall be one of the following:
   1. Schedule 40, PVC pipe and socket fittings, and solvent-cemented joints.
   2. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.
   3. SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.

D. Underground irrigation main piping, NPS 5 and larger, shall be one of the following:
   1. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
   2. SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.

E. Circuit piping, NPS 2 and smaller, shall be one of the following:
   1. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
   2. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

F. Circuit piping, NPS 2-1/2 to NPS 4, shall be one of the following:
   1. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
   2. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

G. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.

END OF SECTION 32 84 00
SECTION 32 91 13 - SOIL PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

B. Related Requirements:

1. Section 31 10 00 "Site Clearing" for topsoil stripping and stockpiling.
2. Section 32 92 00 "Turf and Grasses" for placing planting soil for turf and grasses.
3. Section 32 93 00 "Plants" for placing planting soil for plantings.

1.02 ALLOWANCES

A. Preconstruction and field quality-control testing is part of testing and inspecting allowance.

1.03 DEFINITIONS


B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

H. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

I. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
J. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.


L. SSSA: Soil Science Society of America.

M. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

N. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

O. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

P. USCC: U.S. Composting Council.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include recommendations for application and use.
   2. Include test data substantiating that products comply with requirements.
   3. Include sieve analyses for aggregate materials.
   4. Material Certificates: For each type of imported soil soil amendment and fertilizer before delivery to the site, according to the following:
      a. Manufacturer's qualified testing agency's certified analysis of standard products.
      b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
      c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.
B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.08 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil.

1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.09 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by soil scientist (CPSS) certified by SSSA or state-certified, -licensed, or -registered soil scientist under the direction of the testing agency.

1. Number and Location of Samples: Minimum of eight representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.

2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."

3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.

4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.
1.10 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
   a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."


C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."

3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.

4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT WERA-103, including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm and sodium absorption ratio.
15. Presence and quantities of problem materials including salts and metals cited in
   the Standard protocol. If such problem materials are present, provide additional
   recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's
   "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil
   treatments and soil amendments to be incorporated to produce satisfactory planting
   soil suitable for healthy, viable plants indicated. Include, at a minimum,
   recommendations for nitrogen, phosphorous, and potassium fertilization, and for
   micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per
   1000 sq. ft. for 6-inch depth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for
   lowering pH according to the buffered acidity or buffered alkalinity in weight per
   1000 sq. ft. for 6-inch depth of soil.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers
   showing weight, certified analysis, name and address of manufacturer, and compliance
   with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and
   pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk
   materials, discharge of soil-bearing water runoff, and airborne dust reaching
   adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with
   appropriate certificates.
PART 2 - PRODUCTS

2.01 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Planting-Soil: Imported, naturally formed soil from off-site sources and consisting of loam soil according to USDA textures; and modified to produce viable planting soil.

1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.

2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 6 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.

3. Unacceptable Properties: Clean soil of the following:

   a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

   b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.

   c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 3 inches in any dimension.

4. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

   a. Ratio of Loose Compost to Soil: 1:2 by volume.

2.02 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.03 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC’s "Seal of Testing Assurance," and as follows:

1. Feedstock: Limited to leaves.
2. Reaction: pH of 5.5 to 8.
3. Soluble-Salt Concentration: Less than 4 dS/m.
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content: 50 to 60 percent of dry weight.
6. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.
7. Class: Class I or Class II

2.04 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.
PART 3 - EXECUTION

3.01 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

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

3.02 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 3 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 6 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
   a. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 12 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place.
E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.03 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 6 inches. Remove stones larger than 3 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
   1. Mix lime and sulfur with dry soil before mixing fertilizer.
   2. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.04 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:
1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.

C. Soil will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.06 PROTECTION

A. Protection Zone: Identify protection zones according to Section 01 56 39 "Temporary Tree and Plant Protection."

B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.07 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.
END OF SECTION 32 91 13
SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sodding.

B. Related Requirements:
   1. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.02 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliants, or desiccants.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Product Certificates: For fertilizers, from manufacturer.
C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years’ experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
   a. Landscape Industry Certified Technician - Exterior.
   b. Landscape Industry Certified Lawncare Manager.
   c. Landscape Industry Certified Lawncare Technician.

5. Pesticide Applicator: State licensed, commercial.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk materials with appropriate certificates.

1.08 FIELD CONDITIONS

A. Planting Restrictions: Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 TURFGRASS SOD

A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

1. Sun and Partial Shade: Proportioned by weight as follows:
   a. 50 percent Kentucky bluegrass (Poa pratensis).
   b. 30 percent chewings red fescue (Festuca rubra variety).
   c. 10 percent perennial ryegrass (Lolium perenne).
   d. 10 percent redtop (Agrostis alba).

2.02 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.03 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

   2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

   3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.02 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

   1. Protect grade stakes set by others until directed to remove them.
B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

B. Placing Planting Soil: Blend planting soil in place.
   1. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   1. Lay sod across slopes exceeding 1:3.
   2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.05 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.

2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

   2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

   1. Mow Kentucky bluegrass to a height of 1-1/2 to 2 inches.

D. Turf Postfertilization: Apply commercial fertilizer slow-release fertilizer after initial mowing and when grass is dry.

   1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.06 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

   1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

   2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.
3.07 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselctive): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.08 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.09 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Sodded Turf: 30 days from date of Substantial Completion.

END OF SECTION 32 92 00
SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Plants including the following:
   a. Trees.
   b. Shrubs.
   c. Ground cover.
   2. Plant fertilization.
   3. Mulching.
   5. Pesticides.
   6. Tree stabilization.
   7. Landscape edgings.

B. Related Requirements:

1. Section 01 56 39 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 32 92 00 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.02 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

D. Finish Grade: Elevation of finished surface of planting soil.
E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

G. Planting Area: Areas to be planted.

H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" for drawing designations for planting soils.

I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

L. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.03 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. **Plant Materials**: Include quantities, sizes, quality, and sources for plant materials.

2. **Plant Photographs**: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

### 1.06 INFORMATIONAL SUBMITTALS

**A. Qualification Data**: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer’s capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners’ contact persons.

**B. Product Certificates**: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer’s certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

**C. Pesticides and Herbicides**: Product label and manufacturer’s application instructions specific to Project.

### 1.07 CLOSEOUT SUBMITTALS

**A. Maintenance Data**: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

### 1.08 QUALITY ASSURANCE

**A. Installer Qualifications**: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. **Professional Membership**: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. **Experience**: Five years’ experience in landscape installation in addition to requirements in Section 01 40 00 “Quality Requirements.”
3. **Installer’s Field Supervision**: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer’s field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
   a. Landscape Industry Certified Technician - Exterior.
   b. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

   1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.

   2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

   1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

   3. Accompany each delivery of bulk materials with appropriate certificates.
C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer’s written instructions and warranty requirements.
1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
   b. Structural failures including plantings falling or blowing over.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion.
   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.

3. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.01 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.02 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 21-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.03 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following, and in location(s) indicated on Drawings:

1. Shredded hardwood.
   a. Size Range: 3 inches maximum, 1/2 inch minimum.
   b. Color: Natural.

B. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, consisting of the following type(s), size(s), and color(s), and in location(s) indicated on Drawings:

1. Crushed stone or gravel.
   a. Size Range: 3/4 inch maximum, 1/4 inch minimum.
   b. Color: Readily available natural gravel or stone color range.
2.04 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd..

2.05 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.06 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new softwood with specified wood pressure-preservative treatment, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.

2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.

3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.

2.07 LANDSCAPE EDGINGS

A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   b. Collier Metal Specialties, Inc.
2. Edging Size: 1/4 inch thick by 5 inches deep.
3. Stakes: Tapered steel, a minimum of 15 inches long.
5. Finish: Manufacturer's standard paint.

a. Paint Color: Black.

2.08 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

C. Burlap: Non-synthetic, biodegradable.

D. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.

3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

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

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.03 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

B. Placing Planting Soil: Blend planting soil in place.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

3.04 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

2. Balled and Burlapped Stock: Excavate approximately three times as wide as ball diameter.

3. Container-Grown Stock: Excavate approximately three times as wide as ball diameter.

4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.05 TREE AND SHRUB PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Backfill: Planting soil. For trees, use excavated soil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

   a. Quantity: Two per plant.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
   a. Quantity: Two per plant.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.06 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Do not apply pruning paint to wounds.

3.07 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying:
   a. Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
   b. Stake trees with two stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
2. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.08 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.09 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer’s written instructions. Completely cover area to be mulched, overlapping edges a minimum of 12 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Organic Mulch:
   a. In Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
   b. Around Trees in Turf Areas: Apply mulch ring of 3-inch average thickness, with 24-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.

2. Mineral Mulch:
   a. In Planting Areas: Apply 3-inch average thickness of mineral mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
3.10 EDGING INSTALLATION

A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner’s operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer’s written recommendations.

3.13 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of 4 inches or smaller in caliper size.
2. Provide two new tree(s) of 4-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.

3.14 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.15 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Substantial Completion.

B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: Six months from date of Substantial Completion.
SECTION 33 05 00 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

A. This Section includes the following:
   1. Piping joining materials.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Sleeves.
   5. Identification devices.
   7. Flowable fill.
   8. Piped utility demolition.
   9. Piping system common requirements.
  10. Equipment installation common requirements.
  11. Painting.
  12. Concrete bases.
  13. Metal supports and anchorages.

1.02 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed 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.

C. PVC: Polyvinyl chloride plastic.

1.03 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Dielectric fittings.
   2. Identification devices.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.
1.05 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.07 COORDINATION

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

B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.

C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 03 30 00 "Cast-in-Place Concrete." Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.01 PIPING JOINING MATERIALS

A. 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 otherwise 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

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

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.


G. Solvent Cements for Joining Plastic Piping:
   1. PVC to ABS Piping Transition: ASTM D 3138.

2.02 TRANSITION FITTINGS

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

B. Transition Couplings NPS 1-1/2 and Smaller:
   1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
   2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 and Larger:
   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:
      b. Dresser, Inc.; DMD Div.
      c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
      d. JCM Industries.
      e. Smith-Blair, Inc.
f. Viking Johnson.
g. <Insert manufacturer's name.>

3. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:

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. Spears Manufacturing Co.
   b. <Insert manufacturer's name.>

3. Description: PVCone-piece fitting with manufacturer’s Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

E. Plastic-to-Metal Transition Unions:

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. Colonial Engineering, Inc.
   b. NIBCO INC.
   c. Spears Manufacturing Co.
   d. <Insert manufacturer’s name.>

3. Description: MSS SP-107, PVCfour-part union. Include brass[ or stainless-steel] threaded end, solvent-cement-joint[ or threaded] plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

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:
   b. Fernco, Inc.
   d. Plastic Oddities.
   e. <Insert manufacturer’s name.>
3. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.03 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

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. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Wilkins Div.
   g. <Insert manufacturer’s name.>

3. Description: Factory fabricated, union, NPS 2 and smaller.

   a. Pressure Rating: 150 psig minimum at 180 deg F.
   b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

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. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.
   d. Watts Water Technologies, Inc.
   e. <Insert manufacturer’s name.>

3. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 and larger.

   a. Pressure Rating: 150 psig minimum.
b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

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. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
   e. <Insert manufacturer’s name.>

3. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 and larger.

   a. Pressure Rating: 150 psig minimum.
   b. Gasket: Neoprene or phenolic.
   c. Bolt Sleeves: Phenolic or polyethylene.
   d. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

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. Calpico, Inc.
   b. Lochinvar Corporation.
   c. <Insert manufacturer’s name.>

3. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 and smaller.

   a. Pressure Rating: 300 psig at 225 deg F.
   b. End Connections: Threaded.

F. Dielectric Nipples:

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:
3. **Description:** Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
   
a. **Pressure Rating:** 300 psig at 225 deg F.
b. **End Connections:** Threaded or grooved.

### SLEEVES

**A.** Mechanical sleeve seals for pipe penetrations are specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

**B.** Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

**C.** Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

**D.** Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

**E.** Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

**F.** PVC Pipe Sleeves: ASTM D 1785, Schedule 40.

**G.** Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

### IDENTIFICATION DEVICES

**A.** General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer’s option.

**B.** Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
   
   1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
   2. Location: Accessible and visible.

**C.** Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.
1. **Material**: Brass.
2. **Stencil Paint**: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
3. **Identification Paint**: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

D. **Snap-on Plastic Pipe Markers**: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

E. **Pressure-Sensitive Pipe Markers**: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

F. **Pipes with OD, Including Insulation, Less Than 6 Inches**: Full-band pipe markers, extending 360 degrees around pipe at each location.

G. **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.

H. **Lettering**: Manufacturer's standard preprinted captions as selected by Architect.

I. **Lettering**: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. **Arrows**: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

J. **Plastic Tape**: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.

1. **Width**: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. **Color**: Comply with ASME A13.1, unless otherwise indicated.

K. **Valve Tags**: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. **Material**: 0.032-inch thick, polished brass or aluminum.
2. **Material**: 0.0375-inch thick stainless steel.
3. **Material**: 3/32-inch thick plastic laminate with 2 black surfaces and a white inner layer.
4. **Material**: Valve manufacturer's standard solid plastic.
5. **Size**: 1-1/2 inches in diameter, unless otherwise indicated.
6. **Shape**: As indicated for each piping system.

L. **Valve Tag Fasteners**: Brass, wire-link or beaded chain; or brass S-hooks.
M. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Engraving: Engraver’s standard letter style, of sizes and with terms to match equipment identification.
2. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
3. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

N. Plastic Equipment Markers: Manufacturer’s standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
4. Blue: Equipment and components that do not meet criteria above.
6. Terminology: Match schedules as closely as possible. Include the following:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

O. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.

1. Size: 3-1/4 by 5-5/8 inches.
2. Fasteners: Brass grommets and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.
2.06 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

2.07 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.
   3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
   6. Water: Comply with ASTM C 94/C 94M.
   7. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.01 PIPED UTILITY DEMOLITION

A. Refer to Section 02 41 19 "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
   3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
   5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
3.02 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 and Smaller: Dielectric unions.
2. NPS 2-1/2 to NPS 12: Dielectric flanges or dielectric flange kits.

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 and Smaller: Dielectric couplings or dielectric nipples.
2. NPS 2-1/2 to NPS 4: Dielectric nipples.
3. NPS 2-1/2 to NPS 8: Dielectric nipples or dielectric flange kits.
4. NPS 10 and NPS 12: Dielectric flange kits.

3.03 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. 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 the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

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

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

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
a. **Exception:** Extend sleeves installed in floors of equipment areas or other wet areas **2 inches** above finished floor level.

2. **Install sleeves in new walls and slabs as new walls and slabs are constructed.**
   
a. **PVC Steel Pipe Sleeves:** For pipes smaller than **NPS 6.**
   b. **Steel Sheet Sleeves:** For pipes **NPS 6** and larger, penetrating gypsum-board partitions.

L. **Verify final equipment locations for roughing-in.**

M. **Refer to equipment specifications in other Sections for roughing-in requirements.**

### 3.04 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

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

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

D. **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.

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

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

G. **Grooved Joints:** Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

H. **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," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.

J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic 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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

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

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

N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.05 PIPING CONNECTIONS

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

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

3.06 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.
B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.07 PAINTING

A. Painting of piped utility systems, equipment, and components is specified in Section 09 91 13 "Exterior Painting," Section 09 91 23 "Interior Painting," and Section 09 96 00 "High-Performance Coatings."

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

3.08 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
3. Locate pipe markers on exposed piping according to the following:
   a. Near each valve and control device.
   b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
   c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
   d. At manholes and similar access points that permit view of concealed piping.
   e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.
3.09 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use [3000-psi] <Insert strength>, 28-day compressive-strength concrete and reinforcement as specified in Section 03 30 00 "Cast-in-Place Concrete." Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 05 50 00 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.11 GROUTING

A. Mix and install grout for 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.
SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Pressure pipe couplings.
4. Expansion joints and deflection fittings.
5. Backwater valves.
6. Cleanouts.
7. Drains.
8. Encasement for piping.
10. Channel drainage systems.
11. Catch basins.
13. Stormwater detention structures.
15. Dry wells.
16. Stormwater disposal systems.

1.02 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.03 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins stormwater inlets and. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.
1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

1.06 PROJECT CONDITIONS

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

1. Notify Architect days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.01 PVC PIPE AND FITTINGS

A. PVC Profile Sewer Piping:

2. Fittings: ASTM D 3034, PVC with bell ends.
B. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 35 PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.

C. PVC Gravity Sewer Piping:

D. PVC Pressure Piping:
   2. Fittings: AWWA C900, Class 150 PVC pipe with bell ends

E. PVC Water-Service Piping:
   1. Pipe: ASTM D 1785, Schedule 40 PVC, with plain ends for solvent-cemented joints.
   2. Fittings: ASTM D 2466, Schedule 40 PVC, socket type.

2.02 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.
   1. Bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets
   2. Class III

2.03 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Concrete Pipes: ASTM C 443, rubber.
   2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
2.04 PRESSURE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

2. Dresser, Inc.
3. Ford Meter Box Company, Inc. (The); Pipe Products Div.
4. JCM Industries, Inc.
5. Romac Industries, Inc.
7. Victaulic Depend-O-Lok, Inc.
8. Viking Johnson.

C. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.

D. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig minimum pressure rating and ends sized to fit adjoining pipes.

E. Center-Sleeve Material: Stainless steel.

F. Gasket Material: Natural or synthetic rubber.

G. Metal Component Finish: Corrosion-resistant coating or material.

2.05 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

   a. EBAA Iron Sales, Inc.
   b. Romac Industries, Inc.
   c. Star Pipe Products.
   d. Insert manufacturer's name.
3. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

2.06 BACKWATER VALVES

A. Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   c. Tyler Pipe.
   d. Watts Water Technologies, Inc.
   e. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
   f. Insert manufacturer’s name.

3. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
4. Horizontal type; with swing check valve and hub-and-spigot ends.
5. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
6. Terminal type; with bronze seat, swing check valve, and hub inlet.

2.07 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

   b. MIFAB, Inc.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
   g. Insert manufacturer’s name.
3. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

4. Top-Loading Classification(s): Light Duty, Medium Duty, Heavy Duty

5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

   a. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

3. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.08 DRAINS

A. Cast-Iron Area Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   b. MIFAB, Inc.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

3. Description: ASME A112.6.3 gray-iron round body with anchor flange and round[ secured] grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.

4. Top-Loading Classification(s): Medium and Heavy Duty.
2.09 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Sheet

D. Color: Black.

2.10 MANHOLES

A. Designed Precast Concrete Manholes:

1. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.

2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.


4. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.

5. Steps: Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than [60 inches] <Insert dimension>.

6. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

7. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.

2.11 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.


B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
   a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.
   a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

E. Drainage Specialties: Precast, polymer-concrete units.

1. Large Catch Basins:
   a. 24-by-12-inch polymer-concrete body, with outlets in quantities and sizes indicated.
   b. Gray-iron slotted grate.
   c. Frame: Include gray-iron or steel frame for grate.

2. Small Catch Basins:
   a. 19- to 24-inch by approximately 6-inch polymer-concrete body, with outlets in quantities and sizes indicated.
   b. Gray-iron slotted grate.
   c. Frame: Include gray-iron or steel frame for grate.

F. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

G. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.12 CATCH BASINS

A. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch diameter frame and grate.
4. Steps: Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than [60 inches] <Insert dimension>.
5. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
   1. Size: as indicated.
   2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.
   1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.13 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, per CDOT Standards.

B. .

C. Frames and Grates: Heavy duty, Per CDOT Standards.

2.14 STORMWATER DETENTION STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
   1. Ballast: Increase thickness of concrete as required to prevent flotation.
   2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and cover.
   3. Steps: Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of structure to finished grade is less than [60 inches] <Insert dimension>.
B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

2.15 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."


PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.02 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

   1. Install piping pitched down in direction of flow.
   2. Install piping [NPS 6] <Insert value> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
   3. Install piping with 24 inch minimum cover.
   4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   5. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
   6. Install PVC water-service piping according to ASTM D 2321 and ASTM F 1668.
   7. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.03 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

   2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI’s
   3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
   4. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
   5. Join reinforced-concrete sewer piping according to ACPA’s "Concrete Pipe Installation Manual" for rubber-gasketed joints.
   6. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.04 BACKWATER VALVE INSTALLATION

A. Install horizontal-type backwater valves in piping where indicated.

B. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.

C. Install terminal-type backwater valves on end of piping and in manholes where indicated.
3.05 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, [18 by 18 by 12 inches] <Insert dimensions> deep. Set with tops [1 inch] <Insert dimension> above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.06 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.

B. Embed drains in 4-inch minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in [4-inch] <Insert dimension> minimum concrete around bottom and sides.

3.07 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.08 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.
B. Set frames and grates to elevations indicated.

3.09 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
B. Construct riprap of broken stone, as indicated.
C. Install outlets that spill onto grade, anchored with concrete, where indicated.
D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
E. Construct energy dissipaters at outlets, as indicated.

3.10 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.11 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, flush with finished surface.
B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
C. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides.
D. Fasten grates to channel sections if indicated.
E. Assemble channel sections with flanged or interlocking joints.
F. Embed channel sections in 4-inch minimum concrete around bottom and sides.
3.12 STORMWATER DISPOSAL SYSTEM INSTALLATION

A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill according to chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.

B. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, according to piping manufacturer's written instructions.

3.13 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 22 14 13 "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

   a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

   b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.14 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Section 31 20 00 "Earth Moving."

3.15 IDENTIFICATION

A. Materials and their installation are specified in Section 31 20 00 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.16 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
   b. Option: Test plastic piping according to ASTM F 1417.
   c. Option: Test concrete piping according to ASTM C 924.
6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than [150 psig].
   a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
   b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
C. Leaks and loss in test pressure constitute defects that must be repaired.
D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.17 CLEANING
A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 33 41 00
SECTION 41 22 00 - CRANES AND HOISTS

PART 1 - GENERAL

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED

A. Equipment items as listed below by Equipment Identifier:

1. 5010 Crane, bridge, top running, 5 ton (Ref Part 2.01)

B. Roughing-in, installation of equipment, and final connection of utilities, with labor, services, and incidentals necessary for complete and operational equipment installation.

C. Wiring, and switching between equipment and utilities.

1.02 QUALITY ASSURANCE

A. Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.

B. Manufacturer’s Representative:

1. Installation: Provide a qualified manufacturer’s representative at site to supervise work related to equipment installation, check out, and start up.

2. Training: Provide technical representative to provide training to Owner’s maintenance personnel in operation and maintenance of specified equipment.

3. Quality standards shall meet or exceed ISO-9001.

1.03 SUBMITTALS

A. Product Data: Submit Product Data in accordance with Division 1 of these specifications.

B. Operations and Maintenance Manual:

1. Submit Operations and Maintenance Manuals in accordance with Division 1- General Requirements of these specifications.

2. Provide complete parts, operating, and maintenance manual covering equipment at time of installation.

3. Description of system and components.

4. Schematic diagrams of electrical, plumbing, and compressed air system.
5. Manufacturer’s printed operating instructions.

6. Printed listing of periodic preventive maintenance items and recommended frequency to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.

C. Shop Drawings: Submit Shop Drawings in accordance with Division 1.

1.04 PRODUCT SUBSTITUTIONS

A. Follow requirements specified in Division 1 - General Requirements.

B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, will be at the expense of the Contractor.

C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance will be based on the technical requirements herein as determined by Owner and Architect.

1.05 WARRANTY

A. Warrant work specified herein for one year from substantial completion against defects in materials, functions, and workmanship.

B. Warranty shall include materials and labor necessary to correct defects.

C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish. Defects shall not include damage due to neglect, misuse, or situations resulting from non-performance of a manufacturer’s recommended preventive maintenance schedule.

D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.

E. All parts shall be readily available locally in the United States.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in manufacturer’s containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid and/or dusty conditions.

B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.

C. Provide equipment and material specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.
PART 2 - PRODUCTS

2.01 CRANE, BRIDGE, TOP RUNNING, 5-TON
Equipment Identifier: 5010

A. Manufacturer’s Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer’s name and model to establish minimal acceptable standards of quality, features, performance, and construction.

| a. Kone Cranes, Inc |
| b. Springfield, OH (866) 261-4624 |
| c. Model No.: CXTSks5-TON |

2. Alternate manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

| a. Demag Cranes and Components, Cleveland, OH (440) 248-2400 |
| b. R&M Materials, Springfield, OH (937) 525-5100 |

B. General Requirements:

1. Top running double girder electric overhead traveling cranes shall be designed, manufactured, and tested as per Crane Manufacturers Association of America (CMAA) Specification #70, Revised 2000.

2. Top running and under running single girder electric overhead traveling cranes shall be designed and manufactured as per CMAA Specification #74, Revised 2000.

3. In addition the crane design and installation shall meet all the applicable local, state, and federal laws and OSHA regulations having jurisdiction.

4. Cranes shall operate in the given spaces and shall match the runway dimensions and rails indicated. Crane design shall maximize hook coverage, hook vertical travel, and clear hook height.

5. The crane shall be designed and manufactured to meet the appropriate service conditions based on the particular application. The crane service class shall be clearly indicated by the manufacturer at the time the crane proposal is submitted.
C. Capacities/Dimensions:

1. Overall dimensions:
   a. Span: 46 feet 1 inch (verify exact span in field prior to fabrication)
   b. Runway length: Reference Equipment Drawings 01-Q101C
   c. Clear hook height: 20 feet

2. Lift: Hoist design shall maximize hook coverage, hook vertical travel (i.e. end approach), and clear hook height (i.e. headroom). The use of a low headroom hoist is mandatory.

3. Lifting capacity: 10,000 pounds

4. Lower load block or assembly of hook, swivel bearing sheaves, pins and frames suspended by the hoisting ropes shall not be considered part of the rated capacity.

5. CMAA service Class C

6. Lift: Hoist design shall maximize hook coverage, hook vertical travel (i.e. end approach), and clear hook height (i.e. headroom). The use of a low headroom hoist is mandatory.

7. Rated speeds (FPM) ±10%:
   a. Hoist: Maximum high 20; Minimum low 3.2 FPM
   b. Trolley: Maximum high 65; Minimum low 65 FPM
   c. Bridge: Maximum high 100; Minimum low 100 FPM

D. Features/Performance/Construction:

1. Hoists and trolleys:
   a. Hoist design shall maximize hook coverage, hook vertical travel (i.e. end approach), and clear hook height (i.e. headroom).
   b. All top running and under-running single girder cranes shall utilize low headroom electric wire rope hoists.
   c. All hoists/trolleys shall be supplied with two-speed hoisting contractor controls and inverter trolley speed controls (steeples or programmed two-speed) to minimize load swing and ensure accurate load positioning.
   d. Any proposed equivalent must meet or exceed the dimensional and performance specification of the above-mentioned products.
e. Unless otherwise specified, hoists shall be single revved. Lateral hook drift shall not exceed 1/8 inch per foot of vertical travel, or true vertical lift.

f. The drum to rope diameter ratio shall be a minimum of 30:1 to minimize rope flex and significantly extend rope life. Drum shall be made from steel and supported on heavy-duty anti-friction bearings; groove depth shall be at least 35 percent of rope diameter. The rope drum shall be equipped with a rope guide and spring loaded roller to help keep the rope aligned in the grooves of the drum at all times.

g. Gear reducers shall be integral components of standard hoists or hoist/ trolley units of manufacturers regularly engaged in the design and manufacturing of hoists or hoist/trolley units for Class C cranes. The hoist gearbox must be mounted on angle to the drum to achieve zero gear lash and insure long gear bearing life. The gear reduction units shall be fully enclosed in oil-tight housing. Operation shall be smooth and quiet.

h. Hoisting gears shall be hardened and ground. Gears and pinions shall be spur, helical, or herringbone type only, and shall be forged, steel; open-type gearing is not acceptable. Gears and pinions shall be manufactured to AGMA 2001-B Quality Class 11 or better precision per {AGMA 2000-A}. Gear reducer shall not incorporate a mechanical load brake; the gear reducer shall not require regular internal maintenance (such as mechanical load brake adjustment) and frequent lubricant changes due to friction material contamination and high running temperatures.

i. If a secondary brake is required the brake shall be installed in such a way as to provide redundant braking at each brake application. Secondary brakes, which are not regularly activated and may become inoperative due to lack of use, are not acceptable.

j. The secondary brake shall be a self adjusting DC disc type rated at a minimum of 150 percent of rated motor torque not including regeneration type braking.

k. Each hoist shall be equipped with an electro-mechanical load-limiting device that shall prevent lifting more than 110 percent of the rated load.

l. Hooks shall be made of forged alloy steel (34rMo4 Class T). Hooks shall be fitted with spring loaded safety latches designed to preclude inadvertent displacement of slings from the hook saddle and have 360 degree rotation on anti-friction bearings. Painting or welding shall not be performed on the hook. Hook nut shall be secured with a removable type set screw or other similar fastener;
nut shall not be welded. Hooks shall be designed and commercially rated with safety factors in accordance with CMAA.

m. Bottom block shall be totally enclosed in a steel housing. Rope sheaves shall be supported on heavy-duty anti-friction bearings. Load blocks shall be of steel construction. Load blocks shall be provided with hot-rolled or forged steel fixed crosshead separate from the sheave pin with swivel mounting for forged steel hook. Each lubrication fittings for sheave pins shall be independent type recessed within the sheave pin or adequately guarded to prevent damage.

n. Sheaves shall be of steel or ductile iron (240 to 302 BHN hardness). Sheaves grooves shall be accurately machined, smoothly finished, and free of surface defects. The sheave to rope diameter ratio shall be a minimum of 20:1 to minimize rope flex and extended rope life.

o. Wire rope shall be constructed from galvanized steel having a steel core and a minimum safety factor of 5. (Hoisting ropes shall be the rated capacity load plus the load block weight divided by the number of rope parts, and shall not exceed 20 percent of the certified breaking strength of rope.) Ropes shall be suited to meet the service requirements. Rope socketing or U-bolt clip connections shall be equal to or greater than the rope lengths. Hoisting ropes shall be secured to hoist drum so that no less than two wraps of rope remain at each anchorage of hoist drum at the extreme low position (limit switch stop).

p. Trolley shall be complete with a drive arrangement with a minimum of two-wheel driven by an integral electric motor. Drive mechanism shall run in totally enclosed oil bath. Drive gears shall conform to AGMA 2001-B Quality Class 11 or better. Stop limit switches must be provided for drive mechanism. Acceleration and deceleration controls shall meet requirements specified in this section. Trolley motor shall be inverter duty motor with minimum class “F” insulation. Motors shall have quick disconnect plugs for easy maintenance. Speed shall be infinitely variable from 0 to 50 FPM.

q. Trolley breaking system shall be automatically set when controls are released or power is interrupted. Brakes shall be sealed, dust proof and shall require no adjustment over a million cycles and last the life of the hoist under normal use.

2. Bridge components:

a. High-strength bolted connections shall utilize SAE Grade 5 bolts with corresponding lockwashers, nuts, etc., conforming to requirements of AISC S329 bolts. Bolts, nuts, and washers shall conform to ASTM 325 bolts. Galvanized bolts are not acceptable.
b. Bridge girders shall be constructed from A36 welded box girders, or A36 Structural beams. Girder shall be notched at ends and bolted to top of end trucks with horizontal connection plate utilizing shear rings to absorb horizontal shear forces and to maintain squareness. No “in shear” connections between girders and trucks will be allowed.

c. Bridge end trucks to be constructed of welded box shapes, formed into a rigid tubular housing. Trucks to be equipped with removable rail sweep on each end as well as energy-absorbing bumper. Wheel assemblies shall consist of flat tread, double-flanged, high-quality nodular iron or forged steel wheels, having anti-friction bearing assemblies with whole wheel assembly readily removed for easy repair. Drive wheels shall have rotating axles; idler wheels may be of fixed axle type. End connections shall be made with high-strength bolts.

d. Bridge drives shall be A-4 drive arrangement as specified in MHI CMAA 70. Bridge drive shall consist of a single electric motor mechanically connected through gear reduction and drive shafts to each drive wheel. Gears shall conform to applicable AGMA standards. Gear reducers shall be oil tight and fully enclosed with pressure or splash type lubrication to reduce maintenance and improve reliability.

e. Bridge braking system shall be provided with a spring-applied and electrically released disc brake for each bridge drive motor. Brakes shall have a torque rating of at least 50 percent of bridge drive motor rated torque. Brakes shall be self-adjusting for wear.

f. Wheels shall be manufactured of steel or nodular iron. Wheel treads and flanges shall be rim toughened to between 220 and 300 Brinell hardness number. Bridge and trolley wheels shall be double-flanged. Trolley wheels shall have straight treads. Bridge wheels shall have straight treads. Wheel shall be equipped with heavy-duty anti-friction bearings - no bushings shall be allowed.

g. Where applicable, cranes shall be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment and components, which cannot be made leak-proof, shall be fitted with suitable drip pans. Drip pans shall be manufactured of stainless steel and designed to permit removal of collected lubricant.

h. Electrically controlled brakes shall be fail-safe spring set when power is interrupted. Brakes shall be released with a mainline contractor POWER-OFF push button or a master switch for the associated drive. Brakes shall automatically stop when there is a power failure.
i. Runway (track-type) limit switches shall be provided for crane bridge motion to stop the bridge motion. Trip mechanisms for bridge motion shall be located on crane runway to trip switch before bumper contacts stop. When the switch is tripped, the switch shall permit opposite travel in the direction of stop and then automatically reset.

3. Welding: Welders, welding operations and welding procedures shall be qualified or pre-qualified in accordance with AWS D14.1. The surface of parts to be welded shall be free from rust, scale, paint, grease or other foreign matter. Minimum preheat and interpass temperatures shall conform to the requirements of AWS D14.1. Welding shall be performed in accordance with written procedures, which specify the Contractor’s standard dimensional tolerances for deviation from camber and sweep. Such tolerances shall not exceed those specified in accordance with AWS D14.1. Allowable stress ranges shall be in accordance with MHI CMAA 70. Welding of girders and beams shall conform to AWS D14.1.

4. Markings, labels, and warnings:
   a. Two capacity plates including the crane capacity in tons are required, one secured to each side of bridge crane. Each capacity plate shall be fabricated of steel or a quality/fade-resistant stick-on label with letters large enough to be easily read from the floor. Capacity plates shall be placed in a location visible to pendant operator’s position after the crane has been installed.
   b. Readable warning labels shall be affixed to each lift block or control pendant in a readable position in accordance with ASME B30.16, ASME B30.2 and ASME B30.17. The word “warning” or other legend shall be designed to bring the label to the attention of the following information concerning safe-operating procedures:
      - operating the hoist when the hook is not centered under the hoist;
      - operating hoist with twisted, kinked or damaged rope; with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

5. Crane runway rail: Manufacturer to provide crane runway rail to match end truck wheel assembly with crane stop.

E. Electrical and Control Requirements:
   1. Cranes shall be designed to be operated from a 460 VAC, 3 phase, 60 Hz, alternating current system power source.
   2. The hoist/trolley shall be CAS (US/Canada) approved and/ or UL approved to NEMA 3R protection. Hoist control enclosure shall be rated NEMA 4.
3. Hoisting motors shall be two-speed/two winding squirrel cage type with a speed ratio of 6:1. Hoisting motors effective duty shall be 50 percent ED (30 minute rated) or higher with minimum class “F” insulation. One thermal sensitive device embedded in hoist motor windings shall be provided. Thermal-sensitive device and associated circuits shall be self-restoring (automatic reset). Motors shall be designed specifically for crane and hoist duty.

4. The hoist motor shall be positioned inside the drum to minimize heat build up by directing airflow over the motor in close proximity to the motor housing. The cooling effect of the hoist drum surrounding the motor shall be an acceptable means of directing this airflow, and keeping damaging motor heat to a minimum.

5. Hoist controls shall be full magnetic type, specifically selected for hoisting service. The trolley shall be supplied with variable frequency drive (VFD) controls for two-step or infinitely variable speed control for smooth acceleration and deceleration; minimal load swing and accurate load placement.

6. Hoist shall be equipped with a geared adjustable upper and lower limit switch to limit extreme upper and lower travel of the bottom block assembly. Geared limit switch shall have four positions with the following functions- lower limit, upper slowdown, upper limit, and phase reversal supervision. The upper-most limit shall be wired to the down circuit in such manner to prevent hoisting in the event of a phase reversal.

7. Bridge motors shall be inverter duty motors with minimum class “F” insulation. Motors shall have quick-disconnect plugs for easy maintenance. Travel motors shall have a duty of 40 percent or higher. Motor enclosure shall be TENV (totally enclosed non-ventilated). Provide slow down and stop limit switches at each end of the bridge to insure safe operation. Speed shall be infinitely variable from 0 to 100 FPM.

8. A main line disconnect consisting of a combination circuit breaker (50,000 AIC) and non-reversing starter, starter without overloads (mainline contractor) in NEMA Type 4X enclosure shall be provided. Mainline disconnect shall be controlled by a control circuit so that all crane motions will be stopped upon mainline under voltage, overload, control circuit fuse failure, or operation of POWER-OFF push button. Mainline disconnect shall be equipped with energy isolating devices designed to accept lockout devices.

9. Pendant control station enclosure shall be NEMA 4X Type. Physical size of pendant shall be held to a minimum. A separate cable of corrosion-resistant chain consisting of a minimum 6.4 millimeters (1/4 inch) wire shall be provided. Cable shall be integral with pendant control wire.
10. Push button control enclosure shall be NEMA 4X. Thermal overloads to be provided for all motors. Hoist to be equipped with overload cut-off device. Hoist and trolley control functions to be combined with pushbutton control functions for crane motions.

11. Reduced voltage at pendant push button.

12. Operation push buttons shall be heavy-duty; type with distinctively felt operation positions, which meet requirements of NEMA 4X. Pendant control buttons shall be momentary push buttons. Push buttons (except the POWER-OFF button) shall be recessed type to avoid accidental operation. Diameter of buttons shall be a size, which will make operation possible with a thumb while holding the pendant with the same hand. Nameplates shall be provided adjacent to each push button. In a multi-speed application, dual-position push buttons shall have a definite click-indent position for each speed. Pendant shall include a separate set of pushbuttons for each motion and for POWER-OFF. Push buttons shall be as follows:

a. POWER-OFF
b. POWER-ON
c. Hoist-Up
d. Hoist-Down
e. Bridge-North
f. Bridge-South
g. Trolley-East
h. Trolley-West

13. Bridge span conductor system shall be the festoon type consisting of a support rail, electrical cables, junction boxes, cable cars and accessories. Cable loops shall not drop below the hook high position. Outdoor crane bridge festoon system hardware shall be corrosion resistant.

14. Pendant festoon system shall consist of a support rail, cables, junction boxes, cable cars, and accessories. Cable loops shall not drop below the hook high position. Pendant control car shall be provided with NEMA Type 12 junction box. Outdoor crane pendant festoon system hardware shall be corrosion resistant.

15. Main power electrification system shall provide power to crane starter/disconnect circuit breakers.
F. Accessories:

1. Crane runway rail to match end truck wheel assembly with crane stop.

2. Crane runway conductor system shall be covered conductor bar system type designed and manufactured to meet UL requirements. Protective covers shall be the rigid or flexible self-closing type designed to cover all live conductors and shall be shaped to prevent accidental contact with conductors. Collectors shall be heavy-duty sliding shoe type compatible with the electrification system. Two tandem designed collector heads shall be provided for each conductor rail to provide redundancy.

G. Utility Requirements:

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<td>1. Electrical:</td>
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<th>a. Connection Requirements</th>
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<td>Phase</td>
<td>3</td>
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<td>Amps</td>
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b. Connection Type: Provide disconnect

H. Finish: Bridge crane including bridge, trolley, hoist, and all attached items shall be painted in accordance with the manufacturer's standard practices. Items such as surfaces in contact with the electrical collector bars in contact with the collector shoes and nameplates shall not be painted.

PART 3 - EXECUTION

3.01 INSPECTION

A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.

B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items and specified accessories.

3.02 INSTALLATION

A. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect or designated representative.

B. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:
1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.

2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.

3. Anchorage: Attach equipment as directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.

C. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.03 TESTING

A. After final installation is complete and prior to authorizing payment, specified equipment shall be checked with specifications in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer. Testing report shall be submitted to the Architect or designated representative.

3.04 CLEANUP

A. Touch-up damage to painted finishes.

B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.

C. Clean area around equipment installation and remove packing and installation debris from job site.

D. Notify Architect or designated representative when installation and cleanup is 100% complete and ready for final observation (punchlist).

3.05 TRAINING

A. Direct the technical representative to provide specified hours of training to designated Owner’s maintenance personnel in operation and maintenance of the following equipment. Coordinate, with Owner, training schedule and list of personnel to be trained.

1. 5010 Crane, bridge, top running, 5 ton; 3 hours (minimum)

B. Obtain, from technical representative, a list of Owner’s personnel trained in equipment operations and maintenance.

END OF SECTION 41 22 00
SECTION 45 39 00 - FABRICATED EQUIPMENT

PART 1 - GENERAL

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED

A. Equipment items as listed below by Equipment Identifier:

1. 1860 Workbench, severe use, six foot (Ref Part 2.01)

B. Installation of equipment with labor, services, and incidentals necessary for complete and operational equipment installation.

1.02 QUALITY ASSURANCE

A. Equipment shall be manufactured by a manufacturer of established reputation with a minimum of five years experience performing similar fabrication techniques.

1.03 SUBMITTALS

A. Shop Drawings shall be submitted in accordance with Division 1 - General Requirements of these specifications.

1.04 PRODUCT SUBSTITUTIONS

A. Follow requirements specified in Division 1 - General Requirements.

B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, shall be at the expense of the Contractor.

C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance shall be based on the technical requirements herein as determined by Owner and Architect.

1.05 WARRANTY

A. Warrant work specified herein for one year from substantial completion against defects in materials, functions, and workmanship.

B. Warranty shall include materials and labor necessary to correct defects.

C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish. Defects shall not include damage due to neglect, misuse, or situations resulting from non-performance of a manufacturer’s recommended preventive maintenance schedule.
D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in manufacturer’s containers, appropriately packaged and/or crates for protection during domestic shipment and storage in humid and/or dusty conditions.

B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.

C. Provide equipment and material specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

PART 2 - PRODUCTS

2.01 WORKBENCH, SEVERE USE, SIX FOOT
Equipment Identifier: 1860

A. Manufacturer’s Reference:
   1. Fabricated item as shown on Equipment Layout Drawing.

B. Capacities/Dimensions:
   1. Overall dimensions:

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<tr>
<th>Dimensions (inches)</th>
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<th>Width</th>
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<tr>
<td>a. Equipment</td>
<td>72</td>
<td>32</td>
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   2. Load capacity: 2,500 pounds

   3. Work surface thickness: 3/8 inch

C. Features/Performance/Construction:
   1. Legs: Workbench legs shall be fabricated of 3 by 3 by 3/16 inch steel tube.

   2. Leg braces: Leg braces shall be 3 by 1/4 inch steel plate continuously welded to tubing.

   3. Top braces: Top braces shall be 3 by 3 by 1/4 inch steel angle with continuous electrical welds to tubing.
4. Top: Top shall be 3/8 inch steel plate with 50 percent minimum electrical welds to top braces. Corners of top shall have a 2 inch radius for protection of personnel. All edges shall be ground smooth.

5. Skid plate: Skid plate shall be 4 by 4 by 1/4 inches steel plate with continuous welds to tubing.


D. Finish: Cover all exposed steel surfaces including both sides of top, braces, and legs with one coat of zinc chromate primer and two coats of epoxy per manufacturer’s recommendations in Owner’s choice of color.

PART 3 - EXECUTION

3.01 INSPECTION

A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.

B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items and specified accessories.

3.02 INSTALLATION

A. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect.

B. Install equipment in accordance with plans, shop drawings, and manufacturer’s instructions:

1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.

2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.

3. Anchorage: Attach equipment as directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.

C. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.
3.03 TESTING

A. After final connections are made and prior to authorizing payment, specified equipment shall be tested for compliance with specifications in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer. Testing report shall be submitted to the Architect or designated representative.

3.04 CLEANUP

A. Touch-up damage to painted finishes.

B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.

C. Clean area around equipment installation and remove packing and installation debris from job site.

D. Notify Architect or designated representative when installation and cleanup is 100% complete and ready for final observation (punchlist).

END OF SECTION 45 39 00