PROJECT MANUAL

NEW JEROME ELEMENTARY SCHOOL

for

Jerome School District

Bid Set

Jerome, Idaho
February 11, 2022

VOLUME THREE

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DIVISION 21 – FIRE SUPPRESSION

SECTION 210000 - FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. Specification Section 220000, Plumbing General Requirements, is to be included as part of this Section of the specification.

B. Work Included:

1. This section covers the work necessary to design and install a complete, satisfactory, and ready to operate wet pipe fire protection system for heated areas and dry pipe fire protection system for non-heated areas (areas subject to freezing). Hazard classification shall be as required by the State Fire Marshal, local City, IBC, IFC, and applicable NFPA Standards.

C. Qualifications of Installer:

1. All work shall be performed by a qualified, competent, licensed Fire Sprinkler Contractor who can furnish a verified list of satisfactory installations of this type and size, for a period of 5 years or more. Fire sprinkler contractor shall be licensed by the Idaho State Fire Marshal, and shall have in his employ an Engineering Technician (Level III), certified by NICET (National Institute for Certification in Engineering Technologies).

D. System Responsibility:

1. All work required for the fire protection system, including design and installation, shall be the responsibility of the Fire Sprinkler Contractor. Coordination with other trades is critical. Contractor shall coordinate his work with all ductwork, piping, electrical, etc., to ensure that all systems can be installed with a minimum of interference. Sprinkler heads shall be located in the center of ceiling tiles in the 2’ dimension and quarter spaced on 12” increments in the 4’ dimension. All piping penetrations through finished walls shall be provided with chrome escutcheons. Submittals which are required are only for the purpose of general coordination. Architect/Engineer assumes no responsibility or liability for the design of the system.

2. All monitoring of valves not shown on the electrical drawings shall be within the scope of work for the fire sprinkler contractor. This shall include, but not be limited to, the following: All conduit and wiring as required to monitor post indicator valves, tamper switches, and any other devices required to be supervised by the fire alarm panel. The sprinkler contractor shall also provide all power, wiring and conduit required for a complete and operational dry-pipe system (if required), unless such electrical is shown on the electrical drawings.

3. All dry piping shall be graded to drain back to the riser, regardless of location or presence of heat. Where not possible, piping may be graded to auxiliary drum drip drains. All locations of drains are to be approved by the Architect/Engineer prior to installation. All exposed piping shall be installed as close to ceilings as possible while maintaining appropriate sprinkler deflector clearances and while providing minimum pipe grade per NFPA 13 requirements. Piping shall be designed and installed in a neat and symmetrical manor and shall be coordinated with all other trades and building features.

4. All wet piping may be installed flat and level but shall be installed so as to minimize the requirements for auxiliary drains. All exposed piping shall be installed as close to ceilings as possible while maintaining appropriate sprinkler deflector clearances. Piping shall be designed and installed in a neat and symmetrical manor and shall be coordinated with all other trades and building features.

5. Submittals are required are only for the purpose of general coordination. Architect/Engineer assumes no responsibility or liability for the design of the system.

6. The fire sprinkler system engineering documents must include as a minimum:
   a. The hazard classification, density, water flow and pressure requirements.
   b. The storage arrangement and classification of commodities to be protected.
   c. Confirmation of adequate water supply based on water purveyor data.
   d. Riser location and feed main routing.

1.2 CODES AND STANDARDS:

A. The sprinkler system is to be designed and installed in accordance with the latest applicable building codes, State and Local Fire Marshals requirements, and all applicable NFPA Standards.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

A. The Engineering Technician shall prepare and submit the following submittal data:

1. Complete equipment list of all equipment to be installed, including manufacturer's name and catalog number.

2. Layout drawing of complete sprinkler system indicating relationship of all other overhead items, including ductwork, lights, and structural members.

3. Complete details and sections as required to clearly define and clarify the design.

4. Plot plan indicating location of all underground connections, piping, valves, and related items.

5. Complete building section showing location of piping, sprinklers and applicable equipment in relation to other construction features.

6. Grooved joint couplings and fittings shall be shown on drawings and product

submittals, and be specifically identified with the applicable style or series number.

7. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

8. Sprinkler's valve and equipment model numbers shall be specifically identified on drawings and shall match submittal data provided.

2.2 MATERIALS AND EQUIPMENT:

A. All materials shall be as specified below, or in accordance with applicable NFPA Standards:

1. Piping shall be black steel per NFPA 13 requirements and shall have a factory applied interior MIC or corrosion resistant coating. Piping shall be new and relatively free of exterior rust or corrosion. Piping with excessive rust or corrosion may be rejected. Threadable, thin wall piping will not be allowed. CPVC is allowed for underground only.

2. Fittings shall be 125 psi screwed cast or malleable iron for all threaded piping.

3. Fittings shall be Victaulic FireLock®, Anvil Gruviok, Grinnell or Shurjoint fire protection products for all grooved or plain end piping. Couplings shall consist of two ductile iron housings conforming to ASTM A536, a pressure responsive elastomer gasket, and zinc electroplated carbon steel bolts and nuts. Rigid type or flexible type where necessary.
   a. Rigid Type: Housings shall be cast to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's recommendations. Contractor shall remove and replace any improperly installed joints. 11/4" and Larger: Standard rigid joint equal to Victaulic FireLock® Style 009 or equal.
   b. Flexible Type: Use in seismic areas where required by NFPA 13, Victaulic Style 75 or 77 or equal.

4. Dry pipe valves shall be installed in system risers per local water purveyor requirements.
   a. Dry Pipe Valve: Reliable EX Low Pressure Dry Valve (or preapproved equal, prior to award) shall be provided. Low differential, latched clapper design, black enamel coated ductile iron body, aluminum bronze clapper, with external reset and nitrogen system trim package. Valve internal parts shall be replaceable without removing the valve from the installed position and be externally resettable. Valve shall be pre-trimmed with shut-off valve, 3-way ball valve, and actuator. Required system pressure shall be per manufacturer's requirements. Valve shall have grooved ends for vertical installation only.
   b. Dry pipe systems shall not exceed 750 gallons of total system volume for any reason, regardless of code allowances. The Fire Sprinkler Contractor is to determine how many systems are required and provide the correct number of

systems as determined by their design.

5. A nitrogen generator system, as manufactured by Southtech Systems or Engineered Corrosion Solutions (or preapproved equal prior to award), shall be sized and installed to provide system pressure and maintenance for the dry pipe systems. The system shall be equipped with a fire protection air compressor to comply with pressurization requirements of NFPA 13. Where multiple systems are required, the contractor shall properly size the generator system as needed for all cumulative dry pipe systems. Nitrogen monitoring stations shall be provided on each system per the manufactures criteria. Stations shall be located at or near the remote end of each system and shall be readily accessible from the floor level. The final location shall be coordinated with and approved by the Architect/Engineer.

6. Wet pipe risers shall be equipped with a Reliable brand alarm valve / system check valve.

7. Butterfly control valves with supervisory tamper devices shall be installed for system control.

8. All materials and equipment shall conform to the requirements of Underwriter Laboratories (UL) or Factory Mutual Global (FMG), and shall be so stamped.

9. Pressure switches (water flow device) shall be installed in each system riser (dry pipe systems).

10. Flow switches (water flow device) shall be installed in each system riser (wet pipe systems).

11. Alarm Bell shall be 10-inch outdoor electric bell. Furnish for installation by the electrical contractor.

12. Sway Bracing, both lateral and longitudinal, shall be required and shall be installed per applicable NFPA Standards.

13. Fire Department Connection shall be provided for each system riser or manifold assembly. Install a 90-degree elbow with drain connection at each fire department connection to allow for system drainage to prevent freezing.

14. Sprinkler heads in main entry type areas and main conference room type areas shall be concealed flush mounted style with white paintable covers. All other sprinkler heads shall be Reliable Designer Model F1, (or equal), recessed with compression type escutcheon, below finished ceilings. Where surface mounted obstructions are installed, two-piece escutcheons and pendent sprinklers may be used, if required. Where sprinkler heads are subject to damage such as gymnasiums or mechanical lofts all sprinkler heads shall be provided with protective covers. Escutcheons shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer. Where piping is exposed, install standard bronze upright or pendent sprinklers. Quick response dry sidewall sprinklers shall be used as required to comply with IBC requirements for exterior canopies.

15. Provide 12 extra sprinkler heads mounted together in a suitable cabinet. Include

Reliable brand sprinkler head wrenches matching each type of sprinkler head. Include spares of all types of sprinklers installed in the building.

16. Hangers, drains, and Inspectors Test Connections shall be installed in accordance with applicable NFPA Standards.

17. Test and Drain Valve: Globe design valve providing test port with ½" integral orifice and drain port in one unit. Bronze body with copper alloy internals, polycarbonate sight glasses, Nitrile o-rings and EPDM valve seats.

18. Back flow prevention as required by the State and Local Fire Marshall.

19. Post indicator valves as required by the State and Local Fire Marshall, or as shown on plans.

20. All piping penetrations through finished walls shall be provided with chrome escutcheons.

B. Underground piping materials and installation shall comply with N.F.P.A. #24 and local water company specifications.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Upon completion of the system, secure the inspection of the required authorities and perform such tests as may be required to demonstrate compliance with local and state standards. Upon acceptance of the system by the inspecting authority, inform the Architect/Engineer in writing, showing proof of acceptance. Submit all required test certificates to required authorities.

B. The Fire Sprinkler Contractor shall monitor the nitrogen percentages until the system has reached 98% pure nitrogen and shall provide written verification, signed and acknowledged by the Owner's representative of such achievement. This shall occur each time that the system is taken in and out of service for any reason connected to the requirements of the project.

3.2 INSTALLATION:

A. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by grooved pipe manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. Contractor's field personnel shall be properly trained in the installation of the manufacturer's grooved piping products. A Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

B. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and

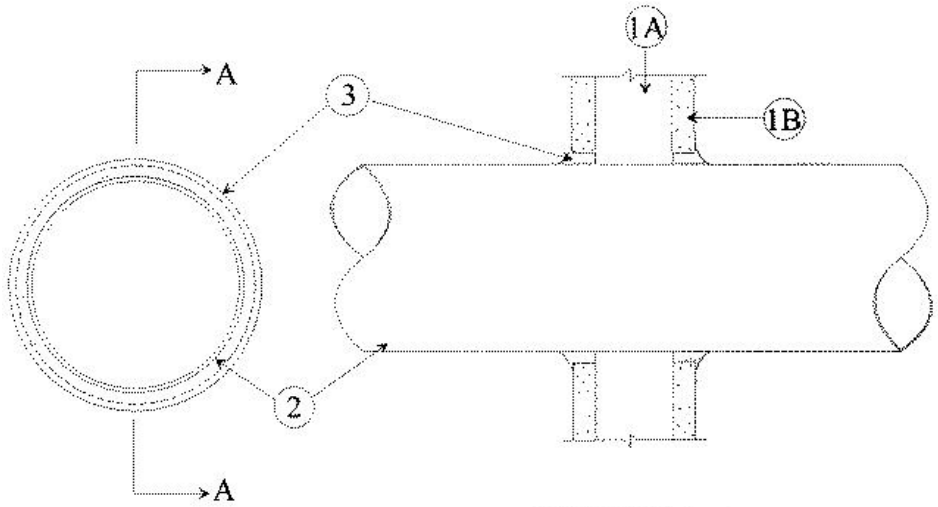
before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

3.3 PROJECT CLOSEOUT

A. Operations & Maintenance Manual:
The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three-ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. In addition, the contractor shall provide two consolidated electronic versions on two separate thumb drives. Individual items will not be accepted independently unless approved by the Engineer. The manual shall be in accordance with NFPA 25 requirements.

END OF SECTION 210000

F Rating — 1 Hr
T Rating — 0 Hr



SECTION A-A

1. **Wall Assembly —** The fire-rated gypsum wallboard/stud wall assembly shall be constructed of the materials and in the manner specified in the individual U300 or U400 Series Wall and Partition Designs in the UL Fire Resistance Directory and shall include the following construction features:

A. **Studs —** Wall framing may consist of either wood studs or steel channel studs. Wood studs to consist of nom 2 by 4 in. lumber spaced 16 in. OC. Steel studs to be min 2-1/2 in. wide and spaced max 24 in. OC.

B. **Gypsum Board* —** One layer of nom 5/8 in. thick gypsum wallboard, as specified in the individual Wall and Partition Design. Max diam of opening is 13-1/4 in.

2. **Through Penetrants —** One metallic pipe, conduit or tubing to be installed either concentrically or eccentrically within the firestop system. Pipe, conduit or tubing to be rigidly supported on both sides of wall assembly. The annular space between the through-penetrant and the periphery of the opening shall be min 0 in. to max 1/4 in. The following types and sizes of metallic pipes, conduits or tubing may be used:

A. **Steel Pipe —** Nom 12 in. diam (or smaller) Schedule 10 (or heavier) steel pipe.

B. **Iron Pipe —** Nom 12 in. diam (or smaller) cast or ductile iron pipe.

C. **Conduit —** Nom 6 in. diam (or smaller) steel electrical metallic tubing or steel conduit.

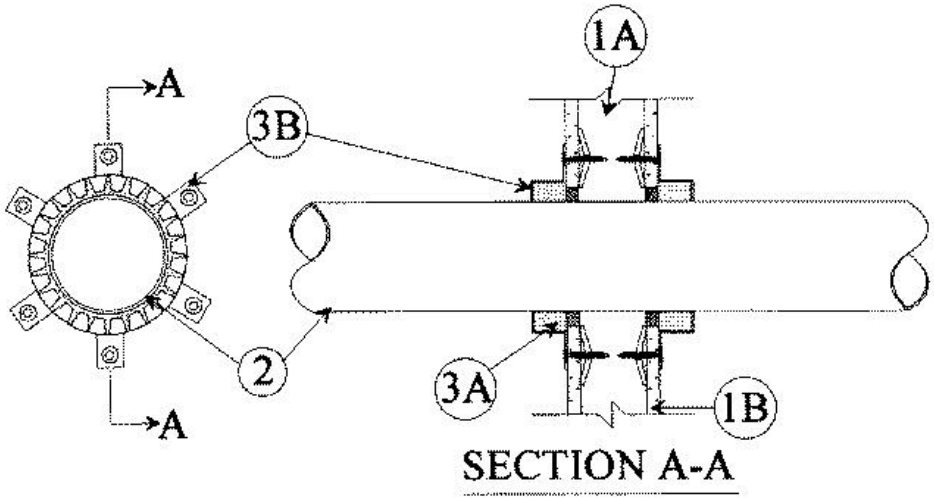
D. **Copper Tubing —** Nom 6 in. diam (or smaller) Type L (or heavier) copper tubing.

E. **Copper Pipe —** Nom 6 in. diam (or smaller) Regular (or heavier) copper pipe.

3. **Fill, Void or Cavity Material* — Caulk —** Fill material to be forced into the annulus to maximum extent possible. Additional fill material to be installed such that a min 1/2 in. crown is formed around the penetrating item and lapping 1/4 in. beyond the periphery of the opening.
RECTORSEAL — Metacaulk 950

*,+ Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

F Rating — 1 Hr
T Rating — 1 Hr



1. **Wall Assembly —** The fire-rated gypsum wallboard/stud wall assembly shall be constructed of the materials and in the manner specified in the individual U300 or U400 Series Wall and Partition Designs in the UL Fire Resistance Directory and shall include the following construction features:

A. **Studs —** Wall framing may consist of either wood studs or steel channel studs. Wood studs to consist of nom 2 by 4 in. lumber spaced 16 in. OC. Steel studs to be min 2-1/2 in. wide and spaced max 24 in. OC.

B. **Gypsum Board* —** One layer of nom 5/8 in. thick gypsum wallboard, as specified in the individual Wall and Partition Design. Max diam of opening is 7-1/4 in.

2. **Through Penetrants —** One nonmetallic pipe to be centered within the firestop system. An annular space of 1/4 to 3/8 in. is required in the firestop system. Pipe to be rigidly supported on both sides of wall assembly. The following types and sizes of nonmetallic pipes may be used:

A. **Polyvinyl Chloride (PVC) Pipe —** Nom 6 in. diam (or smaller) Schedule 40 cellular or solid core PVC pipe for use in closed (process or supply) or vented (drain, waste or vent) piping system.

B. **Chlorinated Polyvinyl Chloride (CPVC) Pipe —** Nom 6 in. diam (or smaller) SDR 17 CPVC pipe for use in closed (process or supply) or vented (drain, waste or vent) piping systems.

C. **Acrylonitrile Butadiene Styrene (ABS) Pipe —** Nom 6 in. (or smaller) diam Schedule 40 cellular or solid core ABS pipe for use in closed (process or supply) or vented (drain, waste or vent) piping systems.

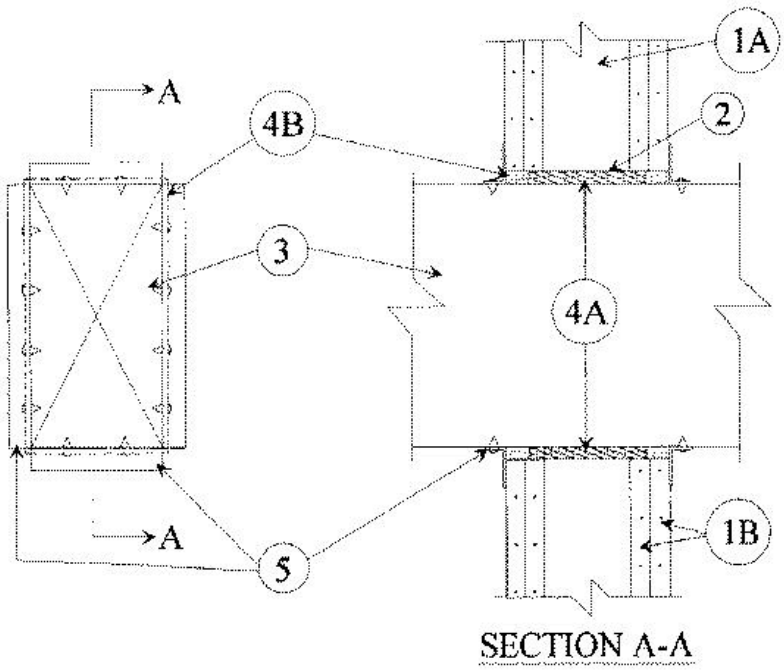
3. **Firestop System —** The firestop system shall consist of the following:

A. **Fill, Void or Cavity Material* — Caulk —** Min 1/2 in. thickness of fill material applied within the annulus, flush with both surfaces of wall.
RECTORSEAL — Metacaulk 1000

B. **Firestop Device* —** Galv steel collar lined with an intumescent material sized to fit specific diam of the through penetrant. Device to be installed around through penetrant in accordance with accompanying installation instructions. Device incorporates anchor tabs for securement to both surfaces of the wall by means of 1/8 in. diameter by 2-1/2 in. long steel hollow wall anchors at each anchor tab.
RECTORSEAL — Metacaulk Pipe Collar

*,+ Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

F Ratings — 1 & 2 Hr (See Item 1)
T Rating — 0 Hr



SECTION A-A

1. **Wall Assembly —** The 1 or 2 h fire-rated gypsum wallboard/stud wall assembly shall be constructed of the materials and in the manner specified in the individual U300 or U400 Series Wall and Partition Designs in the UL Fire Resistance Directory and shall include the following construction features:

A. **Studs —** Wall framing may consist of either wood studs or steel channel studs. Wood studs to consist of nom 2 by 4 in. lumber spaced 16 in. OC. Steel studs to be min 2-1/2 in. wide and spaced max 24 in. OC. When steel studs are used and the max dimension of opening exceeds the width of the stud cavity, the opening shall be framed on all sides using lengths of studs installed between the vertical studs and attached to the studs at each end. The framed opening in the wall shall be 2 to 4 in. wider and 2 to 4 in. higher than the dimensions of the steel duct (Item 3) such that a clearance of 1 to 2 in. is present between the duct and the framing on all four sides.

B. **Gypsum Board* —** Nom 5/8 in. thick, with square or tapered edges. The gypsum wallboard type, number of layers and sheet orientation shall be as specified in the individual Wall and Partition Design. Max area of opening is 188 in. sq with max dimension of 14-1/2 in. for wood stud walls. Max area of opening is 325 in. sq with max dimension of 25 in. for steel studs. The hourly F rating of the firestop system is equal to the hourly fire rating of the wall assembly in which it is intalled.

2. **Steel Wire Mesh —** Sleeve fabricated from No. 8 steel wire mesh and having a min 1 in. lap along the longitudinal seam. Length of steel wire mesh to be 1/2 in. less than thickness of wall, with mesh centered and formed to fit periphery of through opening.

3. **Steel Duct —** Nom 24 by 12 (or smaller) by No. 24 gauge (or heavier) galv steel duct for 1 h walls. Nom 12 by 12 in. (or smaller) by No. 24 gauge (or heavier) galv steel ducts for 2 h walls. One steel duct to be positioned within the firestop system. The annular space between the steel duct and the gypsum wallboard shall be min 0 in. to max 1 in. Duct to be rigidly supported on both sides of wall assembly.

4. **Firestop System —** The firestop system shall consist of the following:

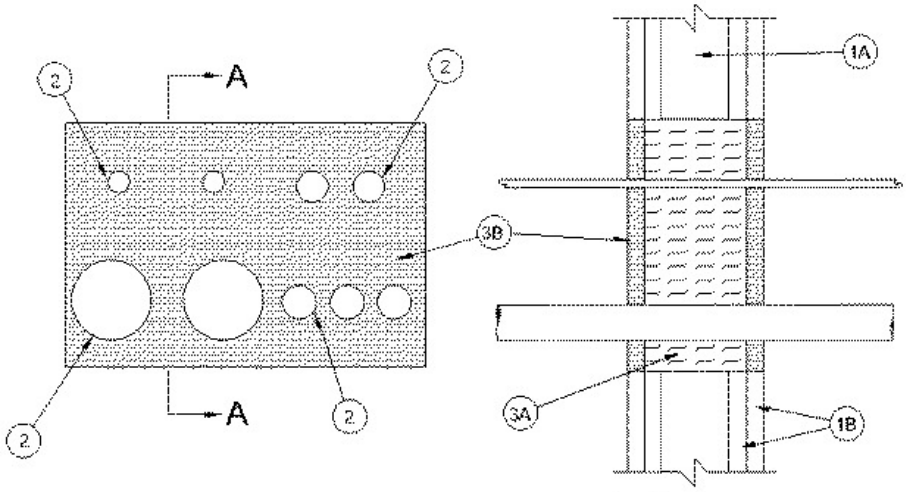
A. **Packing Material —** Min 2-1/4 in. thickness of min 4.0 pcf mineral wool batt insulation firmly packed into opening as a permanent form. Packing material to be recessed from both surfaces of wall as required to accommodate the required thickness of fill material.

B. **Fill, Void or Cavity Material* — Caulk —** Min 3/4 in. thickness of fill material applied within the annulus, flush with both surfaces of wall. At the point contact location between duct and wall, a min 1/4 in. diam bead of fill material shall be applied at the wall/duct interface on both surfaces of wall.
RECTORSEAL — Metacaulk 835+

5. **Steel Retaining Angle —** Nom 2 by 4 by No. 22 gauge (or heavier) steel angles attached to all four sides of the duct on both sides of the wall. The 2 in. leg of the angle shall be attached to the duct with No. 8 (or larger) steel sheet metal screws spaced max of 2 in. from each end and at a max of 5 in. OC.

*,+ Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

ANSI/UL1479 (ASTM E814)	CAN/ULC S115
F Ratings — 1 and 2 Hr (See Item 1)	F Ratings — 1 and 2 Hr (See Item 1)
T Ratings — 0, 1/4, 1/2 or 3/4 Hr (See Items 1A and 2)	FT Ratings — 1 and 1-3/4 Hr (See Items 2 and 3)
	FH Ratings — 1 and 2 Hr (See Item 1)
	FTH Ratings — 1 and 1-3/4 Hr (See Items 2 and 3)



SECTION A-A

1. **Wall Assembly —** The 1 or 2 hr fire-rated gypsum board/stud wall assembly shall be constructed of the materials and in the manner specified in the individual U300, U400, V400 or W400 Series Wall and Partition Designs in the UL Fire Resistance Directory and shall include the following construction features:

A. **Studs —** Wall framing shall consist of either wood or steel channel studs. Wood studs to consist of nom 2 by 4 in. (51 by 102 mm) lumber spaced 16 in. (406 mm) OC. Steel studs to be min 3-1/2 in. (89 mm) deep and spaced max 24 in. (610 mm) OC. Framing of the opening shall consist of steel channel studs.

B. **Gypsum Board * —** The gypsum board type, thickness, number of layers and orientation shall be as specified in the individual Wall and Partition Design. Max area of opening is 200 sq in. (1290 cm^2) with a max dimension of 20 in. (508 mm).

The hourly F and FH Ratings of the firestop system are equal to the hourly fire rating of the wall assembly in which it is installed.

1A. **Steel Sleeve —** (Optional, not shown) - Max 16 in. (406 mm) by 6 in. (102 mm) 24 gauge (or heavier) galvanized steel with min 1 in. (25 mm) flanges. Sleeve to be installed flush with both surfaces of wall and secured to both sides of wall through the flanges with min 1/4 in. (6 mm) diam steel hollow wall anchors in conjunction with steel washers spaced a max 6 in. (152 mm) OC. **When steel sleeve is used, T, FT and FTH Ratings are 0 hr.**

2. **Through Penetrants —** Any combination of the following metallic penetrants to be installed within the firestop system. The annular space between penetrants shall be min 1/4 in. (6 mm) to max 3-1/2 in.(89 mm) and between penetrants and periphery of opening shall be min 1/4 in. (6 mm) to max 2-1/2 in. (64 mm). Penetrants to be rigidly supported on both sides of floor or wall assembly. The following types and sizes of EMT, metal clad cable or conduits may be used:

A. **Conduit —** Nom 4 in. (102 mm) diam (or smaller) electrical metallic tubing. Max two 4 in. (102 mm) diam conduits and max three 2 in. (102 mm) diam conduits per opening. **When 3 or 4 in. (76 or 102 mm) diam EMT is used, T, FT and FTH Ratings are 1/2 hr. When 2 in. (51 mm) diam (or smaller) EMT is used, T, FT and FTH Ratings are 3/4 hr.**

B. **Metal Clad Cable+ —** Nom 2 in. (51 mm) diam (or smaller) 4 conductor 2/0 AWG steel or aluminum **Metal Clad Cable+** with or without PVC jacket. Max two metal clad cables per opening. **When metal clad cable is used, T, FT and FTH Ratings are 1/2 hr.**
See **Through-Penetrating Products** (XLHY) category in Vol. 2 of the Fire Resistance Directory for names of manufacturers.

C. **Flexible Metal Conduit —** Nom 1-1/2 in. (38 mm) diam (or smaller) steel or aluminum **Flexible Metal Conduit±**. Max two flexible metal conduits per opening. **When flexible metal conduit is used, T, FT and FTH Ratings are 1/4 hr**.
See **Flexible Metal Conduit** (DXUZ) category in the Electrical Construction Materials Directory for names of manufacturers.

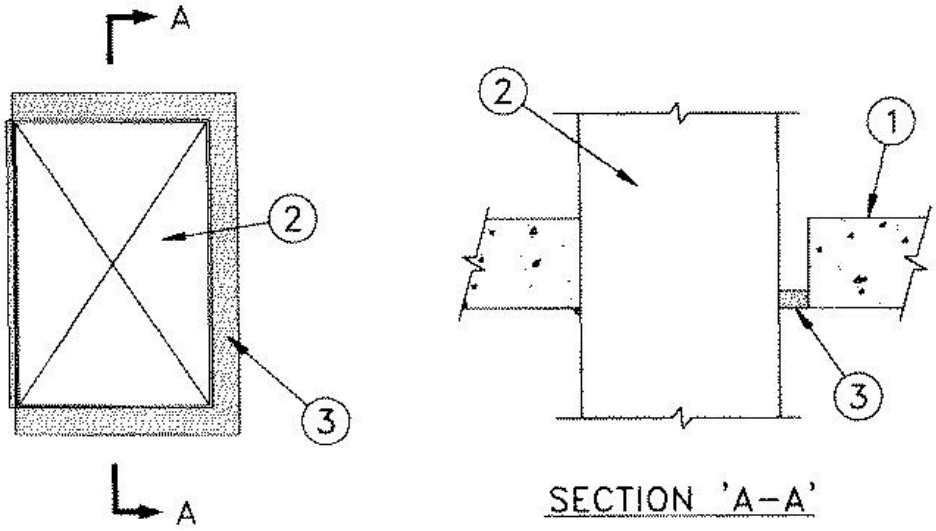
3. **Firestop System —** The firestop system shall consist of the following:

A. **Packing Material —** For 1 or 2 hr fire rated walls, min 3-1/2 in. (89 mm) or 4-3/4 in. (121 mm) thickness, respectively, of min 4 pcf (64 kg/m^3) mineral wool batt insulation firmly packed into opening as a permanent form. Packing material to be recessed from both surfaces of wall to accommodate the required thickness of fill material.

B. **Fill, Void or Cavity Material* - Caulk —** Min 5/8 in. (16 mm) thickness of fill material applied within the annulus, flush with both surfaces of wall.
RECTORSEAL — Metacaulk 1000

*,+ Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

ANSI/UL1479 (ASTM E814)	CAN/ULC S115
F Ratings - 2 Hr	F Ratings - 2 Hr
T Ratings - 0 Hr	FT Ratings - 0 Hr
L Rating At Ambient - Less Than 1 CFM/ft^2	FH Ratings - 2 Hr
L Rating At 400°F - Less Than 1 CFM/ft^2	FTH Ratings - 0 Hr
W Rating - Class 1 (See Item 2)	L Rating At Ambient - Less Than 5.1 L/s/m^2
	L Rating At 204°C - Less Than 5.1 L/s/m^2



1. **Floor or Wall Assembly —** Min 4-1/2 in. (114 mm) thick reinforced light weight or normal weight (100-150 pcf or 1600-2400 kg/m^3) concrete. Floor may also be constructed of any min 6 in. (152 mm) thick UL Classified hollow core **Precast Concrete Units*.** Wall may also be constructed of any UL Classified **Concrete Blocks***. Max area of opening is 364 sq. in. (2348 cm^2) with max dimension of 26 in. (660 mm). When precast concrete units are used the max area of opening is 49 sq. in. (316 cm^2) with max dimension of 7 in. (178 mm).
   See **Concrete Blocks** (CAZT) and **Precast Concrete Units*** (CFTV) categories in the Fire Resistance Directory for names of manufacturers.

2. **Steel Duct —** Nom 24 by 12 in. (610 by 305 mm) (or smaller) by No. 24 gauge (or heavier) galv steel duct. One steel duct to be positioned within the firestop system. The annular space shall be min 0 in. (point contact) to max 2 in. (51 mm). When W Rating applies, the annular space shall be min 1/2 in. (13 mm). Duct to be rigidly supported on both sides of floor or wall assembly.

3. **Firestop System —** The firestop system shall consist of the following:
   A. **Packing Material —** (not shown). Min 1 in. (25 mm) thick polystyrene board, firmly packed into opening as a permanent form. Packing material to be recessed from bottom or top surface of floor or from one surface of wall to accommodate the required thickness of fill material.

   B. **Fill, Void, or Cavity Materials* - Sealant —** Min 1 in. (25 mm) thickness of fill material applied within the annulus, flush with either the top or bottom surface of floor or one surface of wall. When wall is constructed of concrete blocks, fill material shall be installed within the annular space on both sides of the wall. When the floor is constructed of hollow-core precast concrete units, fill material shall be installed on the bottom side of the floor. At the point contact location between duct and concrete a min 3/8 in. (10 mm) diam bead of fill material shall be applied at the concrete/duct interface on the same side of floor or wall as the sealant in the annular space bottom or top surface of floor or one surface of wall. When W Rating applies if sealant is installed flush with top surface of floor.
   RECTORSEAL — FlameSafe® FS900+, Metacaulk MC 150+, Biostop BF 150+

*,+ Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

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DIVISION 22 - PLUMBING

SECTION 220000 – PLUMBING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The Bidding Requirements, Contract Requirements, and the General Requirements (Division 01) of these specifications shall govern all parts of the work.

B. Work Included:

1. Install work in accordance with these specifications and the accompanying plans. Furnish all labor, material, and equipment together with all incidental items not specifically shown or specified which are required by good practice to provide the complete plumbing systems as described.

C. Coordination and Site Visits:

1. This section of the work requires examination of and reference to all architectural, structural, utility, and electrical drawings for construction conditions that may affect the work. Inspect the building site and existing facilities for verification of existing conditions. Base all measurements from established benchmarks. Any discrepancy between actual measurements and those indicated, which prevents following good practices or the intent of the drawings and specifications, shall be reported to the Architect/Engineer, and work halted until instructions are received from the Architect/Engineer.

1.2 CODES, PERMITS, FEES:

A. Install all work in accordance with applicable codes and standards. Obtain all required permits; pay all required fees including utility connections or extensions, in connection with this portion of the construction. Obtain all required certificates of inspection for the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP:

A. Materials:

1. All materials and equipment shall be of first quality, new, full size and weight, standard in every respect, and suitable for the space required. Use the same manufacturer for products of similar class or service, such as valves and pumps. Protect all materials against loss, theft, or damage before and after installation.

2. Furnish and install all necessary foundations, supports, pads, bases, and piers required for all materials and equipment furnished under this contract.

3. Provide all required firestopping at piping penetrations of fire rated walls, floors, ceilings, and roofs. Firestopping shall be Dow Corning Fire Stop Sealant 2000 or Fire Stop Foam 2001, or approved equal.

4. Provide a heat-expanding fire collar for all non-metallic piping up to 6" size at penetrations of fire rated walls, floors, and ceilings per ASTME 814.

B. Workmanship:

1. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. Work shall be installed to the satisfaction of the Architect/Engineer with unsatisfactory work removed and reinstalled to his satisfaction at no extra cost to the Owner.

2. Provide all cutting and patching necessary to install the work specified in this section. Patching shall match adjacent surfaces. No structural members shall be cut without the approval of the Architect/Engineer. Provide all sleeves and inserts required before the floors and walls are built.

3. Locate all equipment that must be serviced in fully accessible positions. Provide clearance for removal of replacement parts and components, and with necessary couplings or flanges to remove the component for maintenance.

2.2 SUBMITTALS AND SUBSTITUTIONS:

A. Prebid Approval:

1. Manufacturer's trade names and catalog numbers stated herein are intended to indicate the quality of equipment or materials desired. All manufacturers not specifically listed require prior approval. Submit catalog data, including specifications, of the proposed equipment to the Architect/Engineer for his approval at least 10 calendar days prior to bid opening. Notice of such approvals will be published in an addendum. Approval of listed alternate equipment manufacturers is for bidding only. Final approval is to be based on requirements of the plans and specifications.

B. Submittals:

1. Within thirty days after award of this contract, provide an electronic copy of a complete list of all materials and equipment proposed for this project. List shall contain make, type, manufacturer's name, and trade designation of all materials and equipment. Submittal shall also include manufacturer's complete specification for each item, including ratings, and dimensions as required to check space requirements. The scheduled equipment is the basis of design for physical size, etc. Alternate manufacturers shall not exceed the weight or physical size. Any changes to the Architectural, Structural and Mechanical systems due to alternate manufactures shall be the responsibility of the Contractor and Supplier. Submittals for fixtures, trim, and other plumbing related items, requiring submittals, shall be submitted in a single complete package. Individual items will not be reviewed independently unless

approved by the Engineer.

2. Approval of submittals shall not relieve the contractor from responsibility for deviations from the plans or specifications, unless he has, in writing, called the Architect's /Engineer's attention to deviations at the time of submission, and obtained his written approval. Approval of submittals does not relieve the contractor from responsibility for errors in shop drawings or literature.

C. Equipment Requiring Submittals:

1. Plumbing Fixtures & Trim

2. All Piping Material

PART 3 - EXECUTION

3.1 ACCESSIBILITY & SAFETY:

A. Accessibility:

1. All equipment which must be serviced or operated shall be located in fully accessible position. Minor changes from the drawings may be made to allow for better accessibility. All changes shall be approved prior to actual installation.

2. Access panels shall be provided if required for accessibility. Access panels to be steel, flanged, hinged doors by Cendrex, model AHD, or equal. Size as required for installation. Subcontractor shall furnish the required panels to the General Contractor and the required location for all access panels, unless otherwise specified in the Architectural specifications. Panels shall be installed by the General Contractor.

B. Safety:

1. No water piping shall run immediately over or within a 3-foot plan view clearance of any electrical panel or motor starter. Where piping must be located within these zones, install piping inside a conduit to prevent water access to electrical equipment.

3.2 COORDINATION:

A. Coordinate all work with the various trades involved to provide a complete and satisfactory installation. The exact details of piping and equipment are not shown. No additional compensation will be made for offsets or relocation required in coordination with other trades.

B. Alterations required due to improper supervision by the subcontractor shall be made at no extra cost, to the satisfaction of the Architect/Engineer.

3.3 EXCAVATION & BACKFILL:

A. Excavate trenches required for underground piping to proper elevation and grade. Provide trenches

with solid bottoms to allow support of piping along entire length with excavation at bells as required for jointing and inspection. Provide repairing of finished surfaces, and all required shoring, bracing, pumping, and protection for safety of persons and property. Observe all Local or State Safety Codes. Verify that elevations of existing utilities will allow for proper grading of piping connecting to existing utilities.

B. Excavation and Backfill shall be in accordance with the requirements of Division 31, of these specifications.

3.4 IDENTIFICATION AND CODING:

A. General:

1. The Contractor shall use ASME 13 standards for all piping identifications, color coding, and compliance.

B. Painting:

1. All painting of equipment, accessories, and piping shall be furnished and applied under the Architectural section of these specifications. All painting shall be completed before any identification markings are applied.

C. Piping:

1. Identify all piping as to the service of the pipe and the direction of flow. The letters shall be 3/4 inch high on piping two inches or smaller, and 1-1/4 inches high on piping up to six inches. Flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and oil base paint, one inch high and black, or factory fabricated plastic pipe markers. Piping shall be identified at 25 foot maximum intervals, on long continuous lines; adjacent to each item of equipment; on each riser and junction, and on both sides of all wall penetrations. Underground piping shall be identified with bright colored continuously printed plastic tape of not less than 6" wide by 4 mil thick, manufactured for direct burial service. Install directly above all buried pipe, 6 to 8 inches below finished grade.

3.5 TESTING:

A. Piping:

1. All plumbing piping (drainage, water, gas) shall be tested in accordance with the requirements of local adopted plumbing code, latest edition. Other piping systems shall be tested hydrostatically to 1.5 times the operating pressure but not less than 100 psi, for a minimum period of two hours. If the test pressure falls more than 5 percent during the test period, the leak shall be located, repaired, and the test repeated.

2. Piping shall be tested before insulation has been installed. Delicate control mechanisms shall be removed during tests to prevent shock damage. The use of chemicals or compounds to stop leaks shall not be permitted.

3. A test report shall be submitted for each piping system test. Test report forms are part of

Specifications Section 220100, or are available from the Engineer.

B. Systems:

1. All plumbing systems shall be tested at the completion of the building to establish that the systems operate as specified and required.

3.6 CLEANING AND ADJUSTING:

A. Thoroughly clean all parts of the system at the completion of the work. Flush all water circulating systems with fresh water and then drain. Clean all strainers and refill system. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

B. All potable water systems shall be flushed and disinfected after tests are completed. Disinfection shall be in accordance with local municipal and State Plumbing Inspector's criteria. In lieu of such criteria, the following procedure shall be followed for disinfection:

1. Completely flush system. Add alkali or acid (hydrochloric) to bring water ph level to between 7.4 and 7.6.

2. Inject chlorine (liquid/powder/tablet/gas) in the system to obtain 50-80 mg/L residual.

3. Bleed water from outlets to ensure distribution, and test for residual at a minimum of 15 percent of the outlets.

4. Maintain disinfection in system for 24 hours.

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

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

7. Take samples no sooner than 24 hours after flushing, from 10 percent of the outlets and the incoming water.

3.7 PROJECT CLOSEOUT:

A. Operations & Maintenance Manual:

The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three-ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. Individual items will not be accepted independently unless approved by the Engineer. The manual shall include, as a minimum:

1. Maintenance instructions for all equipment, including lubrication requirements.

2. Fixture suppliers' names, addresses, and telephone numbers.

3. Fixture catalog cuts, ratings tables, model numbers, serial numbers, and accessories.

4. Parts numbers for all replaceable parts.

5. Valve tagging chart as hereinbefore specified.

6. Guarantee letter as specified below.

7. Any additional information required to enable the Owner to properly maintain the building plumbing system.

8. After approval of the Operations and Maintenance Manual by the Architect/Engineer, the Contractor shall furnish two copies of the manual to the Owner.

B. As-Built-Drawings:

1. Provide two sets of red-line mechanical drawings showing the work as it was actually installed. The drawings shall indicate all departures from the contract drawings and shall locate all underground utility lines with dimensions from established building lines. Make all notations neat and legible, with red indelible pencil. At the completion of the work, these as-built drawings shall be signed and dated by the Plumbing Contractor and returned to the Architect/Engineer.

C. Plumbing System Training Period:

1. After the plumbing system is completely installed and operational, the plumbing contractor shall provide a minimum of **28** hours training and instruction time for the building Owner or his representative. During this period, the contractor shall instruct the Owner in the operation and maintenance of all parts of the plumbing system, using the O & M manual where applicable. The contractor shall provide a copy of the Project Owner Plumbing Systems Training Form (attached to this specification), with proper signatures, to the Engineer prior to substantial completion and ensure that a copy is inserted into the project O & M manuals.

28 hours total training as follows: (20) At project completion
Four (4) 5-hour sessions at owner's direction

(8) 6 months after project completion
One (1) 8-hour session at owner's direction

D. Guarantee:

1. All work furnished under this section shall be guaranteed in writing to be free from defective work or materials for a period of one year after acceptance of the contract. All repairs or replacements because of defective materials or workmanship or noncompliance with code shall be provided without additional cost to the Owner. Contractor shall furnish a letter indicating above guarantee with space for date of acceptance and expiration of guarantee. Letter shall be included in O & M Manual.

END OF SECTION 220000

SECTION 220100 - PLUMBING

PART 1 - GENERAL

1.1 SCOPE:

A. This section covers the work necessary for the plumbing system, complete. The Plumbing General Requirements, Section 220000, are to be included as a part of this section of the specifications.

1.2 CODES:

A. The plumbing system shall be installed in accordance with the requirements of local adopted plumbing code, latest edition, International Fuel Gas Code, latest edition; and all local and State Codes.

1.3 FIXTURES & EQUIPMENT:

A. General:

1. Plumbing fixtures and equipment shall be as listed on the drawings. In addition to those specifically listed, the following manufacturers are approved for bidding only. All other manufacturers require prior approval. Final approval for installation is based on submittal data furnished:
   a. Tank Type Water Closets: American Standard, Kohler, Mansfield, Sloan, Toto, & Zurn.
   b. Flush Valve Water Closets: American Standard, Briggs, Kohler, Mansfield, Sloan & Zurn.
   c. Urinals: American Standard, Briggs, Gerber, Kohler, Mansfield, Sloan, Toto & Zurn.
   d. Vitreous China Sinks: American Standard, Crane, Kohler, Mansfield, Sloan, Toto, & Zurn.
   e. Stainless Steel Sinks: Elkay, Just.
   f. Faucets: American Standard, AMTC, Aquaspec, CHG Encore Saniguard, Chicago Faucets, Delta, Elkay, Gerber, Geberit, Kohler, Moen, T&S Brass, Symmons, Sloan & Zurn.
   g. Sensor Faucets: Chicago Faucets, Elkay, Mac Faucets, Symmons, Sloan, & T & S Brass.
   h. Valves and Trim: Brasscraft, Dearborn Brass, ProFlo, Sloan & T&S Brass.
   i. Flush Valves: American Standard Selectronic, AMTC, Delta, Kohler, Moen (sensor-operated only) Sloan, & Zurn.
   i. Carriers and Drainage Products: Jay R. Smith, MIFAB, Neenah Foundry, NDS, Sun Drainage, Wade, Watts, & Zurn.
   j. Toilet Seats: American Standard, Beneke, Church, Kohler, Plumb Tech & Zurn.
   k. Mixing Valves: Acorn Controls, Lawler, Leonard, Powers, Stingray, Symmons, Watts, & Wilkins.
   l. Fiberglass/ Acrylic Fixtures: Aquatic, Aquaglass, Best Bath, Fiat, Intersan, MAXX, Mustee Praxis-Comfort Designs, & Swan.
   m. Drinking Fountains/ Electric Water Coolers: Elkay, Halsey Taylor, Haws, Murdock Stern Williams, & Sunroc.
   n. Safety Fixtures & Safety Mixing Valves: Acorn, Bradley, Chicago Faucets, Encon, Guardian, Haws, Lawler, Speakman, Stingray.
   o. Security Fixtures: Acorn, Bradley, Willoughby.
   p. Wash Fountains: Acorn, Bradley, Intersan, Sloan, & Willoughby.
   q. Service Sinks: Acorn, Fiat, Mustee, Proflo, Stern Williams, & Zurn.
   r. Water Heaters (Tank): American, A.O. Smith, Bock, Bradford-White, Heat Transfer-Phoenix, Lochinvar Shield, PVI, & Rheem.
   s. Water Heaters (Instantaneous - Gas): A.O. Smith, Bradford-White, Lochinvar, Rheem, & Rinnai.
   t. Water Heaters (Instantaneous - Electric): Bradford-White, EeMax, Chronomite, & Rheem.
   u. System Valves: Apollo, Nebco & Red-White Valve Corp.
   v. Backflow Preventers: Conbraco/Apollo, Watts, & Wilkins.

w. Hose Bibbs: Josam, J.R. Smith, Prier, Woodford, & Zurn.
x. Trench Drains: ABT, ACO, Dura Trench, J.R. Smith, NDS, Strongwell Polycast, Rapid, Wade, & Zurn.
y. Utility Sinks: Fiat, Mustee, & Proflo.

2. Plumbing Fixture Standards:
All plumbing fixtures shall meet or exceed the following standards:
a. ANSI A112.6.1 - Supports for Off-the Floor Plumbing Fixtures for Public Use.
b. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
c. ANSI A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
d. ANSI A112.19.2 - Vitreous China Plumbing Fixtures.
e. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
f. ANSI A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
g. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
h. ANSI Z124.1 - Gel-Coated Glass-Fiber Reinforced Polyester Resin Bathtub Units.
i. ANSI Z124.2 - Gel-Coated Glass-Fiber Reinforced Polyester Resin Shower Receptor and Shower Stall Units.
j. ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
k. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
l. AWSI/ASSE 1001 – Atmospheric Vacuum Breaker
m. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.
n. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
o. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
p. ANSI/ASSE 1015 – Backflow Preventers, Double Check Principle
q. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
r. AWSI/ASSE 1020 – Pressure Vacuum Breaker
s. AWSI/ASSE – 1-52 – Hose Connection, Double Check
t. ANSI A112.21.1 - Floor Drains.
u. ANSI A112.21.2 - Roof Drains.
v. ANSI A112.26.1 - Water Hammer Arresters.
w. PDI WH-201 - Water Hammer Arresters.
x. ANSI/AWWA C606 – Grooved and Shouldered Joints
y. NSF/ANSI Standard 61 – Drinking Water System Components – Health Effects

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES & TRIM:

A. All plumbing fixtures shall be provided complete with all required trim for a complete and operational system. All piping penetrations through finished walls shall be provided with chrome escutcheons. All plumbing fixtures shall be caulked and sealed to surrounding surfaces. All sink traps shall be provided with a cleanout plug in the bottom of the trap. All interior exposed pipe, valves, and fixture trim shall be chrome plated, including kitchen compartment sinks. Braided stainless steel pipe risers are approved for concealed locations only, such as behind casework doors or lav shields. Each fixture shall be provided with stop valves and the stop valves shall be quarter-turn brass ball type. All fixtures and trim must be lead free. All floor drains and floor sinks shall be provided with trap primers (PPP, Zurn or Wade as needed for appropriate use. Provide ball valve type shut-off valve upstream of all trap primer valves).

2.2 PIPING AND FITTINGS:

A. General:

1. Underground sanitary sewer and storm drain lines shall be installed at 1/4" per foot slope, unless otherwise indicated. If such slope is not possible due to existing inverts, approval shall be obtained from the Architect/Engineer and the authority having jurisdiction before any piping is installed at a lesser slope.

2. Connections between piping of dissimilar materials shall be made with dielectric waterway fittings or unions.

3. Provide standard manufactured water hammer arresters at all flush valves. Size and locate per manufacturers recommendations. Provide access panels for access to all water hammer arresters.

B. Domestic & Non-Potable Hot and Cold Water:

1. Piping inside building above slab or above grade in crawl space shall be ASTM B88, Type "L", hard drawn copper. Fittings shall be ANSI/ASME B16.22 cast brass, or ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASTM B32 solder, Grade 95-5, lead free.
   a. Cold Water Only Option- ANSI/ASME B16.18 cast bronze, or ANSI/ASME B16.22 wrought copper. Joints shall be copper-tube dimensioned grooved joint couplings, and Flush Seal style gasket. (Gasket shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Victaulic Style 606, Gruvlok style 6400, Grinnell Universal Tongue and Groove 672, Shurjoint C305, or equal.
   b. Piping Option – Mechanically Formed Extruded Outlets:
      1) Mechanically formed extruded outlets shall be perpendicular to the axis of the run tube (header). They shall be formed by drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the branch wall and shall conform to ASME B31.9 and NFPA 99. T-Drill or approved equal.
      2) Branch tubes shall not restrict the flow in the run tube. To ensure this by conforming the branch tube to the shape of the inner curve of the run tube, a dimple / depth stop shall be formed in the branch tube to ensure that penetration into the collar is of the correct depth. For inspection purposes, a second dimple shall be placed 0.25 inch above the first dimple. Dimples shall be aligned with the tube run.
      3) Branches can be formed up to the run tube size as shown in ASTM F 2014. Forming procedures shall be in accordance with the tool manufacturer's recommendations.
      4) Joints shall be made with the use of approved brazing alloys BCup2 thru BCup5 (0-15% silver content). Brazed with a filler that has a melting point above 540 deg. Centigrade (1000 deg. F). **Soft soldered joints are not allowed.**
      5) K and L copper types allowed.
      6) Soft and Hard copper allowed.
      7) Each model used for making branch connections shall be permanently marked with manufacturer's name and appropriate model number.
      8) Mechanically formed extruded outlets can (but not limited to) be used on commercial and residential buildings.
      9) Fitter / Plumber shall be trained and certified to operate the equipment.

2. Piping underground within 5 feet of the building line, smaller than 4 inches, shall be ASTM B88, Type "K", hard drawn copper. Piping below floor slab, smaller than 4 inches, shall be type "K", soft annealed copper. Fittings shall be ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASTM B32 solder, Grade 95-5, lead free. No joints shall be installed beneath concrete floor slabs, unless approved by the Engineer. Underground or underslab copper piping shall be provided with a polyethylene jacket, ANSI/AWWA C105, or shall be wrapped with double layer, half-lapped, 10 mil polyethylene tape.
   a. Underground (below slab) Piping Option- ½" to 4", High Density Polyethylene (HDPE) pressure pipe. ASTM D3350, ASTM D3035 & ASTM F714. AWWA C901 & AWWAC906, NSF. Fittings shall be HDPE, solvent weld. Piping shall be rated for not less than 150 psig.
   b. Trap Primer Piping (below floor or concealed only) –
      1) ½" type K hard drawn copper, wrapped as indicated above.

3. Piping underground beyond 5 feet from building line shall be Schedule 40 PVC, ASTM D1785 or D2241. Fittings shall be PVC, ANSI/ASTM D2466. Joints shall be solvent weld, ASTM D2855, or gasketed, ASTM F477. Piping shall be rated for not less than 150 psig pressure.

C. Sanitary Sewer and Vent:

1. Piping and fittings shall be Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent

welded per solvent manufacturer's instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235. All sewer risers (2 story or more) shall be service weight cast iron, no-hub or single-hub, ASTM A74. All piping penetrations through fire rated walls, floors, or ceilings, and all piping located above ceilings used as return air plenums shall also be cast iron or galvanized steel, ASTM A53. Underground PVC-DWV piping shall be installed per ASTM D-2321.

2. All sanitary waste and grease piping for commercial type kitchens shall be Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent welded per solvent manufacturer's instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235. Cast iron piping shall extend downstream minimum 20 feet from the steam kettle.

3. Piping and fittings beyond 5 feet from the building line shall be PVC, ASTM D3033 or D3034, SDR 35. Joints shall be ASTM F477 with elastomeric gaskets. Underground piping shall be installed per ASTM D-2321.

4. All 90 degree waste line elbows shall be formed per the latest issue of the adopted plumbing code, latest edition.

5. All exposed vent piping located in occupied areas or rooms, is to be cast iron with cast iron fittings.

6. All flush valve fixtures that are installed back to back shall have offset waste outlet fittings.

7. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping which is more than 100 feet and shall be provided for each 100 feet developed length, or fraction thereof of such piping. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred and thirty-five degrees, per applicable plumbing code. This shall be provided regardless of what is shown on the drawings.

8. All floor drains, floor sinks, and hub drains shall be installed with a trap primer.
   a. Flush Valve Primer: Trap primer shall be Precision plumbing products model FVP-1VB with vacuum breaker.
   b. Pressure Activated Primer: Trap primer shall be Precision Plumbing products Model CPO-500 with DU distribution unit if required.
   c. Tail Piece Primer: Trap primer shall be Precision Plumbing Products Model LTP-1500 with ½" braided stainless steel flexible priming make up water line and chrome plated escutcheons plates.

9. All vent's through roof (VTR'S) shall be extended at least 1 foot above the roof surface, or to the top of the closest adjacent parapet wall, whichever is greater.

D. Storm Drains:

1. All horizontal piping and fittings shall be either Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent welded per manufacturer's instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235 or service weight cast iron, ASTM888 no-hub or single hub, ASTM A74.

   All vertical piping shall be service weight cast iron, ASTM888 no-hub or single hub, ASTM A74.

   All underground piping shall be installed per ASTM D-2321.

2. Piping underground beyond 5 feet from the building line shall be PVC, ASTM D3033 or D3034, SDR 35, with PVC fittings. Joints shall be ASTM F477 with elastomeric gaskets. Underground piping shall be installed per ASTM D-2321.

3. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping 2" size which is more than 50 feet and shall be provided for each 50 feet developed length and 4" size or larger which is more than 100 feet developed length, or fraction thereof of such piping. Contractor shall coordinate with architect

as to exact location of all storm water cleanouts as they exit the building, as cleanouts may need to be positioned within certain block elevations. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred and thirty-five degrees, per applicable plumbing code. This shall be provided regardless of what is shown on the drawings. Final determination of cleanout spacing shall be per local jurisdiction and code requirements and shall be installed accordingly.

E. Natural Gas:

1. Piping shall be Schedule 40 black steel pipe, ASTM A53. Exposed fittings 2 inches and smaller shall be ANSI/ASME B16.3, screwed, black malleable iron.

2. Fittings larger than 2 inches and all underground fittings shall be Schedule 40 steel butt-welded type. Underground piping shall be provided with a polyethylene jacket, ANSI/AWWA C105, or shall be wrapped with double layer, half-lapped, 10 mil polyethylene tape.
   a. Contractors Option for Underground Pipe:
      1) Gastite Type PE flexible corrugated gas piping. NFPA-54 & 56. ASTM D2513 Category 1. ASME D-B31.8-1995.
      2) Piping and fittings underground and outside the building line may be JM Eagle UAC 2000 MDPE, medium-density polyethylene yellow gas pipe or an approved equal. Piping shall be installed in accordance with JM Eagle Publication JME-12B, "Polyethylene Yellow Gas Distribution Installation Guide." JM Eagle's UAC 2000 system can be joined by butt heat fusion, socket fusion, or saddle fusion. Installing contractor shall be licensed for fusion pipe installation of polyethylene pipe. ASTM D2513.

3. All exterior piping exposed to the weather shall be coated with a rust inhibitor – Rustoleum #866 Pro-Guard Primer – yellow or gray color – or approved equal.

F. Condensate Drain Piping:

1. Exterior to building (connected to roof mounted equipment): Piping shall be Schedule 40 PVC. A union shall be installed directly at the roof top equipment for ease of replacement in the future.

2. Located within a plenum: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints. Copper piping shall not be used on 90% condensing type equipment

3. Interior: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, or may be Schedule 40 PVC. Copper piping shall not be used on 90% condensing type equipment. Provide a neoprene or rubber gasket at all copper piping support hangers to inhibit corrosion.
   a. Inside Mechanical Rooms: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, for durability reasons.

G. Hanger and Supports:

1. Pipe hangers shall be provided to adequately support all piping systems. Hangers shall be vertically adjustable to provide for proper pitch and drainage. Hangers shall allow for expansion and contraction of the piping system. Reference "General Regulations" of the latest edition of the adopted plumbing code, latest edition.

2. Hangers for pipe sizes 1/2 to 6 inches shall be adjustable clevis type, or unistrut saddles with all-thread hanger rod.

3. Hangers for hot pipe, sizes 6 inches and over shall be adjustable steel yoke, cast iron roll, double hanger type.

4. Vertical pipes shall be supported with steel riser clamps. Spacing interval requirements per "General Regulations" of the latest edition of the adopted plumbing code, latest edition.

5. All insulated piping shall be provided with minimum 18 gauge galvanized insulation shields, 12 inches long, and oversized hangers. Pipe sizes 2 inches and over shall also be provided with 12 inch long calcium silicate insulating blocks between the piping and the galvanized insulation shield.
    a. Alternate: Insulated pipe support inserts may be provided at hanger, support, and guide locations on piping requiring insulation. The insert should consist of either Hydrous Calcium Silicate or Polyisocyanurate Foam insulation (Urethane) encircling the entire circumference of the pipe with a 360 deg. PVC (1.524 mm thick) or galvanized steel jacket and installed during the installation of the piping system. These insulated pipe support inserts shall be provided by the Mechanical Contractor and installed by the same during pipe support installation.

6. Hanger rod sizing and spacing for pipe shall be as follows:

Pipe Size	Minimum Rod Diameter	Maximum Spacing
To 1-1/4 inches	3/8 inch	6.5 feet
To 2 inches	3/8 inch	10 feet
To 3 inches	1/2 inch	10 feet
To 6 inches	5/8 inch	10 feet
8 to 12 inches	7/8 inch	12 feet
PVC & ABS (all sizes)	3/8 inch	4 feet
Cast Iron No-Hub	5/8 inch	5 feet and at joints

7. Provide hangers within 12 inches of each horizontal elbow.

8. Provide hangers with minimum 1-1/2 inches vertical adjustment.

2.3 INSULATION:

A. General:

1. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

2. Fire-Test-Response Characteristics: Insulation and related materials NFPA 255, UL Classified per UL 723 or meeting ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement containers, with appropriate markings of applicable testing and inspecting agency.
    a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
    b. Insulation Installed Outdoors: Flame=spread index of 75 or less, and smoke-developed index of 150 or less.

B. Piping:

1. All domestic, potable & non-potable, hot and cold water lines and rain drains shall be insulated with preformed insulation.
    a. Fiberglass insulation with a vapor barrier jacket. Insulation shall have a conductivity not exceeding 0.28 Btu-inch/hour-sq. ft.-degrees F. Laps and butt joints shall be sealed with pressure sensitive joint sealing tape of the same finish as the insulation jacket to provide a continuous vapor seal. Fittings and valves shall be insulated with PVC fitting covers and fiberglass insulation inserts, or with hydraulic setting insulating cement and four ounce canvass jacket with vapor barrier adhesive.
    b. Alternate material for Cross-Linked Polyethylene Tubing (PEX): One piece preformed flexible elastomeric closed cell foam with built-in vapor barrier. Seal laps and butt joints with moisture resistant adhesive to provide a continuous vapor seal. Insulation shall have a conductivity rating not exceeding 0.27 Btu-

inch/hour-sq. ft.-°F.

Insulation thicknesses shall be as follows:

System	Pipe Sizes ½" and above
Domestic Cold Water (pot. & non-pot.)	½"
Domestic Hot Water & Recirc. (pot. & non-pot.)	1"
Roof Drain Piping	½"
Overflow Drain Piping	½"

2. Roof and overflow drain sumps shall be insulated with 1/2" thick fiberglass with a vapor barrier, extending 2" onto adjacent insulation.

3. Insulation shall be installed in strict accordance with manufacturer's instructions.

4. Insulation shall be continuous through penetrations.

5. All insulation shall be installed in a neat and workmanlike manner.

2.4 VALVES & STRAINERS:

A. Gate Valves:

1. Valves 2-inches and smaller shall be cast bronze body, ASTM B-62, rising stem, 200 psi WOG. Stems shall be dezincification-resistant silicon bronze, ASTM B-371, or low-zinc alloy, ASTM B-99, NSF/ANSI 61-8 Annex F&G, NSF 372 Lead Free. If unable to use a rising stem valve due to inadequate clearance, use non-rising stem gate valve. Valves shall comply with MSS SP-80. Valves over 2-inches shall be iron body, bronze trim, rising stem and hand wheel, flanged ends. Valves shall comply with MSS SP-70. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain, wheel, and guides. Basis of design: Apollo # 101T-LF/101S-LF Lead Free Bronze, Apollo #611F-LF Lead Free Cast Iron, or equal.

B. Globe Valves:

1. Valves 2-inches and smaller shall be cast bronze body, ASTM B-62, renewable composition disc, 200 psi WOG, ASTM B-62, rising stem and hand wheel. Stems shall be of dezincification-resistant silicon bronze, ASTM B-371, or low-zinc alloy, ASTM B-99, NSF/ANSI 61-8 Annex F&G, NSF 372 Lead Free. Valves over 2-inches shall be iron body, bronze trim, rising stem and hand wheel, plug type disc, flanged ends. Valves shall comply with MSS SP-85. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain, wheel and guides. Basis of design: Apollo #120T-LF/120S-LF Lead Free Bronze, Apollo #711F-LF Lead Free Cast Iron, or equal.

C. Ball Valves:

1. Valves 2-inches and smaller shall be lead free cast bronze body, chrome-plated brass ball, teflon seats, and lever handle, 600 psi CWP. Valves shall comply with MSS SP-110, NSF/ANSI 61, NSF/ANSI 372 Lead Free. Valves over 2-inches shall be cast steel body, chrome plated steel ball, teflon seats, and lever handle. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint ball valves are acceptable if grooved piping is used. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain, wheel, and guides. Basis of design: Apollo #77CLF-A Series or equal.

D. Butterfly Valve:

1. Valves 12-inches and smaller shall be ductile iron lug body, ASTM A-536, 316 stainless steel disc, EPDM Liner, 316 stainless steel stem, and safety twist-lock multi-position lever handle with open-closed lockout capabilities.

Valve shall be rated at 175 psig WOG. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain wheel and guides. Valves shall comply with MSS SP-67. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint butterfly valves are acceptable if grooved piping is used.

E. Check Valves:

1. Valves 2-inches and smaller shall be bronze body Y-pattern, ASTM B-62, swing check, bronze disc, 200 psi WOG. Valves shall comply with MSS SP-80, NSF/ANSI 61-8 F&G, NSF/ANSI 372 Lead Free. Valves, over 2-inches shall be iron body, ASTM A-126, bronze trim, swing check, renewable disc and seat. Valves shall comply with MSS SP-71. Victaulic, Anvil Gruvlok, Grinnell, or Shurlock check valves are acceptable if grooved piping is used. Basis of design: Apollo # 161T-LF/161S-LF Lead Free Bronze, Apollo # 920F-LF Lead Free Cast Iron, or equal.

2. Swing check valves with outside lever and spring (not center guided) is to be used on sewage ejector or storm-water sump pumps. Basis of design: Apollo # 910FLW-LF Lead Free Cast Iron or equal.

F. Pressure Reducing Valves:

1. Valves 2-inches and smaller shall be bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, and single union end. Basis of design: Apollo # 36ELF Series Lead Free Bronze or equal.

G. Balance Valve:

1. Valve shall have a twin tube 316 S.S. design with blowout proof attachment to station body. Ports shall include ¾" port for thermometer, ¼" port for pressure gauge, air vent, and ½" drain port.

2. The instrument station shall be 120/150-flanged construction.

3. The butterfly valve shall be lug pattern with a rating of 200 WP, 250 deg. F. The valve shall have an infinite. Position operator with memory stop (6" and smaller), worm gear with memory stop (8" and larger).

H. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.

3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig (862 kPa).

I. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, inline pump, and elsewhere as indicated. Install NPS ¾ (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blow-off connection for strainers smaller than NPS (DN50).

PART 3 - EXECUTION

3.1 WORKMANSHIP:

A. General:

1. Install all piping, fixtures, equipment, and accessories as shown, and in strict accordance with the plumbing laws, rules, and regulations of the State and/or City. All work shall be done in a neat and orderly fashion and left in a

condition satisfactory to the Architect/Engineer.

B. Piping:

1. All piping shall be run parallel or perpendicular to established building lines. Install piping so as to allow for expansion. Waste and vent piping occurring above floor slab shall be installed true and plumb. Extend vents at least 1 foot above roof, or to the top of the closest adjacent parapet wall, whichever is greater, and provide watertight flashing sleeves. Excavation and backfill shall be in accordance with Section 220000 of these specifications.

C. Fixtures:

1. Install fixtures true and plumb with building walls. Caulk all plumbing fixtures at joints along walls, countertops, and other intersecting surfaces. Locate fixtures as shown and per manufacturer's instructions. Furnish all required trim for fixtures to provide a complete and workable installation.

3.2 TESTS:

A. General:

1. All piping, fixtures, and equipment shall be inspected and approved before concealing or covering. All work shall be tested as required by Section 220000 of these specifications and shall be leak proof before inspection is requested. All tests shall be repeated if required by those making the inspection.

2. All potable water systems shall be flushed and disinfected in accordance with Section 220000 of these specifications. Following disinfection, system shall be flushed and water sampled to show compliance with requirements of public health authority having jurisdiction. If tested water does not meet requirements, disinfecting shall be repeated until water quality meets requirements.

3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gasket shall be molded and produced by Victaulic Company, Gruvlok, or Grinnell Mechanical Products, or equal. Verify gasket grade is suitable for the intended service. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel the use of grooving tools, application of groove, and installation of grooved end products.
   a. All grooved joint couplings, fittings, valves and specialties shall be the products of Victaulic Company, Gruvlok, Grinnell Mechanical Products, or equal.

4. Install the grooved piping in accordance with the latest recommendations as published by the manufacturer. Pipe shall be square cut, +/-0.30”, properly deburred and cleaned. Mark pipe ends at the required location using a gauge supplied by the manufacturer to ensure full insertion into the coupling or fitting during assembly. Use a manufacturer’s tool with the proper sized jaw for pressing.

B. Fixtures and Equipment:

1. Fill all plumbing fixtures with water and check for leaks or retarded flow. Repair as required. Adjust each piece of plumbing equipment as required to ensure proper functioning. Leave all fixtures and equipment in first class operating condition.

2. The Plumbing Contractor is responsible for all backflow devices to be inspected by a certified backflow technician before use of the building potable water system.

C. Smoke Test:

1. A smoke test shall be performed on the entire waste and vent system before building occupancy. After all

fixtures are permanently connected and traps are filled with water, fill entire drainage systems with smoke under pressure of 1.3 pKa (1 inch of water) with a smoke machine. If leaks are detected, they shall be repaired and the smoke test shall be performed again until no leaks are found.

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PIPING SYSTEM TEST REPORT

STRUCTURE/BUILDING: _____ TEST NUMBER: _____

LOCATION: _____ CONTRACT NO._____

DESCRIPTION OF SYSTEM/PIPING BEING TESTED: _____

_____

_____

Description of Test Performed	Test Pressure	Test Duration	Pass/Fail
Hydrostatic: _____	P.S.I.	_____	_____
Inert Gas: _____	P.S.I.	_____	_____
Compressed Air: _____	P.S.I.	_____	_____
Waste & Vent Smoke Test**:** _____	1" Water Column	_____	_____

NAME AND TITLE OF PERSON IN CHARGE OF PERFORMING TEST'S FOR CONTRACTOR:

Name: _____ *Title:* _____

Signature: _____

I hereby certify that the above described system has been tested as indicated above and found to be entirely satisfactory as required in the contract specifications.

Signature of Inspector: _____ *Date:* _____

REMARKS: _____

_____

_____

_____

_____

END OF SECTION 220100

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SECTION 220800 – COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The purpose of the plumbing start-up is to provide the owner of the facility with a high level of assurance that the plumbing system has been installed and operates per the requirements of the mechanical construction plans and specifications. The Plumbing General Requirements, Section 220000, is to be included as a part of this section of the specifications.

B. Pre-start and Start-up checklist:

1. The contractor shall be responsible for the completion of the pre-start and start-up checklist forms.

2. After completion of pre-start and start-up checklists, the contractor shall provide a copy of the pre-start and start-up checklist to the engineer for review and approval prior to substantial completion.

PART 2 – START-UP PROCESS

2.1 RESPONSIBILITIES

A. Plumbing Contractor:

1. Coordinate with other trades involved in the installation of mechanical equipment to complete the requirements of mechanical start-up specifications.

2. Complete the pre-start and start-up checklist forms obtained from the equipment manufacturer or the Engineer.

3. Notify the mechanical engineer of tests to be witnessed. Contractor shall give the engineer a minimum of 48 hours notice prior to test.

B. Engineer:

1. Review the completed pre-start and start-up check lists provided by the plumbing contractor.

2. At final inspection, spot check items on the pre-start and start-up checklist forms to ensure that they have been completed.

2.2 EQUIPMENT PRE-START

A. Before starting any equipment or system, complete the system pre-start checklist with forms provided. As part of the pre-start process, the following items shall be completed as applicable:

1. Piping systems shall be pressure tested as specified, found to be tight, with reports submitted.

2. Piping systems shall be flushed and cleaned as specified, all required reports submitted, and the system shall be filled or charged per plans.

3. Seismic restraints shall be installed per plans and specifications.

4. Electrical services shall be installed and checked.

5. Safety controls shall be installed and operation checked.

6. Equipment has been thoroughly cleaned (interior and exterior of units), of construction debris.

7. Deficiencies or incomplete work shall be corrected and pre-start shall be repeated until the installation is ready for operation.

2.3 TESTING

A. Piping:

1. All plumbing piping (drainage, water, gas) shall be tested in accordance with the requirements of the Idaho State Plumbing Code, latest edition. Other piping systems shall be tested hydrostatically, to 1.5 times the operating pressure, but not less than 100 psi, for a minimum period of two hours. If the test pressure falls more than 5 percent during the test period, the leak shall be located, repaired, and the test repeated.

2. Piping shall be tested before insulation has been installed. Delicate control mechanisms shall be removed during tests to prevent shock damage. The use of chemicals or compounds to stop leaks shall not be permitted.

3. A test report shall be submitted for each piping system test. Test report forms are available from the Engineer.

2.4 CLEANING AND ADJUSTING:

A. Thoroughly clean all parts of the system at the completion of the work. Flush all water circulating systems with fresh water and then drain. Clean all strainers and refill system. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

B. All potable water systems shall be flushed and disinfected after tests are completed. Disinfection shall be in accordance with local municipal and State Plumbing Inspector's criteria. In lieu of such criteria, the following procedure shall be followed for disinfection:

1. Completely flush system. Add alkali or acid (hydrochloric) to bring water ph level to between 7.4 and 7.6.

2. Inject chlorine (liquid, powder, tablet, or gas) throughout the system to obtain 50 to 80 mg/L residual.

3. Bleed water from outlets to ensure distribution, and test for residual at a minimum of 15 percent of the outlets.

4. Maintain disinfection in system for 24 hours.

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

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

7. Take samples no sooner than 24 hours after flushing, from 10 percent of the outlets and the incoming water.

PART 3 – EXECUTION

A. The following systems and equipment shall be completed under the plumbing start-up plan as described above and documented with equipment pre-start and start-up forms provided:

1. Domestic Hot Water Heaters
2. Hot Water Recirculation Pumps
3. Tempering Valves

B. Pre-start and start-up forms are to be provided to the engineer for final approval before substantial completion.

C. Approved forms shall be included in the operations and maintenance manual.

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Phone:
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PIPING SYSTEM TEST REPORT

STRUCTURE/BUILDING: _____ TEST NUMBER: _____

LOCATON: _____ CONTRACT NO.: _____

DESCRIPTION OF SYSTEM/PIPING BEING TESTED: _____
_____

_____

_____

Description of Test Performed	Test Pressure	Test Duration	Pass/Fail
Hydrostatic: _____	P.S.I.	_____	_____
Inert Gas: _____	P.S.I.	_____	_____
Compressed Air: _____	P.S.I.	_____	_____
Other **(describe below):** _____	P.S.I.	_____	_____

NAME AND TITLE OF PERSON IN CHARGE OF PERFORMING TEST'S FOR CONTRACTOR:

Name: _____ Title: _____

Signature: _____

I hereby certify that the above described system has been tested as indicated above and found to be entirely satisfactory as required in the contract specifications.

Signature of Inspector: _____ Date: _____

REMARKS:

_____

_____

_____

_____

_____

END OF SECTION 220800

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

SECTION 230000 - HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The Bidding Requirements, Contract Requirements, and the General Requirements (Division 1) of these specifications shall govern all parts of the work.

B. Work Included:

1. Install work in accordance with these specifications and the accompanying plans. Furnish all labor, material, and equipment together with all incidental items not specifically shown or specified which are required by good practice to provide the complete mechanical systems as described.

2. The HVAC Contractor(s) and all Sub-tier Contractors shall provide installed equipment cut sheets and purchase orders required for utility rebates.

C. Coordination and Site Visits:

1. This section of the work requires examination of and reference to all architectural, structural, utility, and electrical drawings for construction conditions that may affect the work. Inspect the building site and existing facilities for verification of existing conditions. Base all measurements from established benchmarks. Any discrepancy between actual measurements and those indicated, which prevents following good practices or the intent of the drawings and specifications, shall be reported to the Architect/Engineer, and work halted until instructions are received from the Architect/Engineer.

1.2 CODES, PERMITS, FEES:

A. Install all work in accordance with applicable codes and standards. Obtain all required permits; pay all required fees including utility connections or extensions, in connection with this portion of the construction. Obtain all required certificates of inspection for the work.

PART 2 - PRODUCTS

It shall be the responsibility of the mechanical contractor (and/or his supplier) to fully review and approve the mechanical equipment and controls submittals PRIOR to any mechanical equipment submittal being forwarded to the design team. All integration issues shall be fully coordinated between the mechanical contractor, the electrical contractor, and the controls contractor PRIOR to any submittal to the engineer. This statement shall be fully visible on all mechanical equipment submittals or they shall be rejected without review.

2.1 MATERIALS AND WORKMANSHIP:

A. Materials:

1. All materials and equipment shall be of first quality, new, full size and weight, standard in every respect, and suitable for the space required. Use the same manufacturer for products of similar class or service, such as valves, pumps, controls, and air handlers. Protect all materials against loss, theft, or damage before and after installation.

2. Furnish equipment that will operate under all conditions of load without any sound or vibration that is objectionable in the opinion of the Architect/Engineer. Vibration or noise considered objectionable will be corrected by the Subcontractor at his expense.

3. Furnish and install all necessary foundations, supports, pads, bases, and piers required for all materials and equipment furnished under this contract.

4. Provide all required firestopping at duct penetrations of fire rated walls, floors, ceilings, and roofs. Firestopping shall be Dow Corning Fire Stop Sealant 2000 or Fire Stop Foam 2001, or approved equal.

B. Workmanship:

1. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. Work shall be installed to the satisfaction of the Architect/Engineer with unsatisfactory work removed and reinstalled to his satisfaction at no extra cost to the Owner.

2. Provide all cutting and patching necessary to install the work specified in this section. Patching shall match adjacent surfaces. No structural members shall be cut without the approval of the Architect/Engineer. Provide sleeves at all piping penetrations of exterior walls and floors on grade. Provide all sleeves and inserts required before new floors and walls are built.

3. Locate all equipment that must be serviced in fully accessible positions. Provide clearance for removal of replacement parts and components, and with necessary couplings or flanges to remove the component for maintenance.

C. Protection of Equipment During Construction:

1. At the end of each shift, all duct openings and open ends shall be covered with a plastic poly sheeting film to protect against dust and construction contamination from entering the ductwork.

2.2 SUBMITTALS AND SUBSTITUTIONS:

A. Prebid Approval:

1. Manufacturer’s trade names and catalog numbers stated herein are intended to indicate the quality of equipment or materials desired. All manufacturers not specifically listed require prior approval. Submit catalog data, including specifications, of the proposed equipment to

the Architect/Engineer for his approval at least 10 calendar days prior to bid opening. Notice of such approvals will be published in an addendum. Approval of listed alternate equipment manufacturers is for bidding only. Final approval is to be based on requirements of the plans and specifications.

B. Submittals:

1. Within thirty days after award of this contract, provide an electronic copy of a complete list of all materials and equipment proposed for this project. List shall contain make, type, manufacturer's name, and trade designation of all materials and equipment. Submittal shall also include manufacturer's complete specification for each item, including capacities, ratings, etc., and dimensions as required to check space requirements. The scheduled equipment is the basis of design for capacity, weights, physical size, etc. Alternate manufacturers shall not exceed the weight or physical size. Any changes to the Architectural, Structural, Mechanical, Electrical, and Control systems due to alternate manufactures shall be the responsibility of the Contractor and Supplier. Submittals for each major trade (i.e., dryside HVAC, wetside HVAC, or Plumbing) shall be submitted in a single complete package. Individual items will not be reviewed independently unless approved by the Engineer.

2. Approval of submittals shall not relieve the contractor from responsibility for deviations from the plans or specifications, unless he has, in writing, called the Architect's /Engineer's attention to deviations at the time of submission, and obtained his written approval. Approval of submittals does not relieve the contractor from responsibility for errors in shop drawings or literature.

C. Equipment Requiring Submittals:

1. Packaged Rooftop Units

2. Ductless Split Systems

3. Electric Heaters

4. Hot Water Boilers

5. Heat Exchangers

6. Pumps

7. Destratification Fans

8. Energy Recovery Units

9. Variable Frequency Drives

10. Miscellaneous Hydronic System Support Equipment

11. Water Source Heat Pumps

12. Exhaust Fans

13. Hoods

14. Grilles / Diffusers / Louvers

15. Pipe Stands

16. Ductwork

17. Flex Duct

PART 3 - EXECUTION

3.1 ACCESSIBILITY & SAFETY:

A. Accessibility:

1. All equipment which must be serviced or operated shall be located in fully accessible position. Minor changes from the drawings may be made to allow for better accessibility. All changes shall be approved prior to actual installation.

2. Access panels shall be provided if required for accessibility. Access panels to be steel, flanged, hinged doors by Cendrex, or equal. Sized as required for installation. Subcontractor shall furnish the required panels to the General Contractor and the required location for all access panels, unless otherwise specified in the Architectural specifications. Panels shall be installed by the General Contractor.

B. Safety:

1. Subcontractor shall provide guards for all belt drives and rotating machinery.

3.2 COORDINATION:

A. Coordinate all work with the various trades involved to provide a complete and satisfactory installation. The exact details of ductwork and equipment are not shown. No additional compensation will be made for offsets or relocation required in coordination with other trades.

B. Alterations required due to improper supervision by the subcontractor shall be made at no extra cost, to the satisfaction of the Architect/Engineer.

3.3 ELECTRICAL:

A. Electric motors required for equipment specified in this section shall be provided and installed by this Subcontractor. Motor starters, disconnects, relays, pilot lights, etc., are in general, to be furnished and installed by the Electrical Contractor. Starters, relays, controls, etc., which are factory assembled into packaged equipment shall be furnished by the Mechanical Contractor under this section of the specifications.

B. All motors shall be provided with adequate starting and protective equipment as specified or

required. Motor capacity shall be sufficient to operate driven device under all conditions of operation and load without overload. Minimum horsepower shall be as specified.

3.4 IDENTIFICATION AND CODING:

A. Painting:

1. All painting of mechanical equipment, accessories and ductwork shall be furnished and applied under the Architectural section of these specifications. All painting shall be completed before any identification markings are applied.

B. Equipment:

1. Identify all equipment with a black Formica label, with white reveal when engraved. Lettering to be 3/16 inch high minimum. In general, identify equipment as to area served in addition to title and code number of the equipment as taken from the plans.

C. Piping:

1. Identify all piping as to the service of the pipe and the direction of flow. The letters shall be 3/4 inch high on piping two inches or smaller, and 1-1/4 inches high on piping up to six inches. Flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and oil base paint, one inch high and black, or factory fabricated plastic pipe markers. Piping shall be identified at 25 foot maximum intervals, on long continuous lines; adjacent to each item of equipment; on each riser and junction, and on both sides of all wall penetrations. Underground piping shall be identified with bright colored continuously printed plastic tape of not less than 6" wide by 4 mil thick, manufactured for direct burial service. Install directly above all buried pipe, 6 to 8 inches below finished grade.

3.5 TESTING:

A. Systems:

1. All systems, including heating, ventilating and air conditioning, shall be tested at the completion of the building to establish that the systems operate as specified and required. Testing shall be performed after air balancing is completed.

2. All controls shall be calibrated accurately and all equipment shall be adjusted for satisfactory operation. Excessive vibration or noise from any system shall be corrected.

3. The air conditioning system shall be tested for satisfactory operation when the outside air temperature reaches 60 degrees F. or warmer. All other systems shall be tested at building completion. All tests shall be performed in the presence of the Architect/Engineer or his representative.

3.6 BALANCING:

A. Scope:

1. Prior to final acceptance by the Owners, all air systems shall be balanced to deliver the quantities as specified or directed. The air balance shall be performed by an independent agency specializing in balancing and is certified by the National Environmental Balancing Bureau.

2. The Mechanical Contractor shall provide assistance to the Balancing Contractor by identifying all installed mechanical systems and assisting access to all installed mechanical systems. All mechanical systems shall be completely operational and functional prior to the Balancing Contractor performing their specified work.

B. Air balancing:

1. Balancing of the air system shall consist of:
   a. Adjust all air volumes to the quantities shown, with allowable variation of plus 10, minus 10 percent.
   b. Record all system, zone, diffuser, grille, and register C.F.M. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Balancing Engineer shall work with the Contractor to set minimum & maximum CFM quantities for zone dampers, or zone dampers/heaters.
   c. Test and record all system static pressures, inlet and discharge, on all packaged units, fans, and terminal units. Vary total system air quantities by adjustment of fan speeds. Provide drive changes as necessary. Vary branch air quantities by damper regulation.
   d. Test and record motor full load amps and nameplate amps.
   e. Test and record entering and leaving temperatures at all coils.
   f. Adjust all automatically operated dampers, in cooperation with the Control Contractor, to the required settings. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions within specified tolerances. Where modulating dampers or economizers are provided, take measurements at full return air, minimum outside air, and 100 percent outside air mode of operation.
   g. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and excessive noise where possible.
   h. Mark final positions of all balance dampers with a red felt pen.
   i. Air systems shall be balanced in accordance with standard procedures and recognized practices of the Associated Air Balance Council, and the Testing Adjusting, and Balancing Bureau.

C. Water Balancing:

1. Balancing of the water system shall consist of:
   a. Adjust all heating and cooling water system flows to within 10 percent of the design quantities shown.
   b. Record all system and terminal unit g.p.m.'s.
   c. Test and record all pump, coil, boiler, heat transfer elements, and chiller entering and leaving water temperatures and pressures.
   d. Test and record all pump full load amps and nameplate amps.
   e. Mark all final positions of all balancing cocks, valves, and operators with a centerpunch.

D. Quality Assurance:

1. The Balancing Contractor shall demonstrate to the Engineer of record, flow verification for at least 10% of the balanced devices as selected by the Engineer. If more than 25% of the tested devices do not meet the designed or balance report, then the entire system balance must be rebalanced.

E. Balance Reports:

1. Submit four copies of the air and water system balance reports to the Architect/Engineer for evaluation and approval. Reports shall be on TABB/SMACNA forms that indicate information addressing each of the testing methods, readings, and adjustments.

3.7 CLEANING AND ADJUSTING:

A. Thoroughly clean all air conditioning units, air handling units, and all associated parts of the system at the completion of the work. Install new, clean air filters in all systems. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

3.8 PROJECT CLOSEOUT:

A. Operations & Maintenance Manual:
The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three-ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. In addition, the contractor shall provide two consolidated electronic versions on two separate thumb drives. Individual items will not be accepted independently unless approved by the Engineer. The manual shall include, as a minimum:

1. Maintenance instructions for all equipment, including lubrication requirements.

2. Equipment suppliers' names, addresses, and telephone numbers.

3. Equipment catalog cuts, ratings tables, model numbers, serial numbers, and accessories.

4. Parts numbers for all replaceable parts.

5. Air and/or water systems balance report as hereinbefore specified.

6. Control diagram or drawing and operation sequence.

7. Valve tagging chart as hereinbefore specified.

8. Filter chart listing unit callout, size of filters, and quantity of filters.

9. Guarantee letter as specified below.

10. Any additional information required to enable the Owner to properly maintain the building mechanical system.

11. Mechanical Equipment Start-up forms, which are included in this specification, if they are

required.

12. After approval of the Operations and Maintenance Manual by the Architect/Engineer, the Contractor shall furnish two copies of the manual to the Owner.

B. Mechanical System Training Period:

1. After the mechanical system is completely installed and operational, the mechanical contractor shall provide a minimum of **40** hours training and instruction time for the building Owner or his representative. During this period, the contractor shall instruct the Owner in the operation and maintenance of all parts of the mechanical system, using the O & M manual where applicable. The contractor shall provide a copy of the Project Owner Mechanical Systems Training Form (attached to this specification), with proper signatures, to the Engineer prior to substantial completion and ensure that a copy is inserted into the project O & M manuals.

40 hours total training as follows: (20) At project completion
Four (4) 5 hour sessions at owner's direction

(10) 6 months after project completion
Two (2) 5 hour sessions at owner's direction

(10) 1 year after project completion
Two (2) 5 hour sessions at owner's direction

C. As-Built-Drawings:

1. Provide two sets of red-line mechanical drawings showing the work as it was actually installed. The drawings shall indicate all departures from the contract drawings. Make all notations neat and legible, with red indelible pencil. At the completion of the work, these as-built drawings shall be signed and dated by the Mechanical Contractor and returned to the Architect/Engineer.

D. Guarantee:

1. All work furnished under this section shall be guaranteed in writing to be free from defective work or materials for a period of one year after acceptance of the contract. All repairs or replacements because of defective materials or workmanship or noncompliance with code shall be provided without additional cost to the Owner. Contractor shall furnish a letter indicating above guarantee with space for date of acceptance and expiration of guarantee. Letter shall be included in O & M Manual.

END OF SECTION 230000

NAME OF PROJECT: _____

_____

OWNER MECHANICAL SYSTEM TRAINING FORM

Upon completion of the equipment and systems installation and connections, the contractor shall assemble all required equipment factory representative and subcontractors together for system Owner training.

These people shall assist in Owner training their system(s) and remain at the site until the total system operations is acceptable and understood by the Owner's representative(s), maintenance and/or operation personnel, on operation and maintenance of their equipment. To prove acceptance of operation and instruction by the Owner's representative(s), the contractor shall provide a copy of this form, with proper signatures, to the Engineer prior to substantial completion, and ensure that a copy is inserted into the project Operation and Maintenance manuals.

> "I, the Contractor, associated factory representative and subcontractors, have started each system and the total system(s); and have proven their normal operation to the Owner's representative(s) and maintenance/operation personnel and have instructed him/them _____, hours in the operation and maintenance thereof."

_____	_____
Owner's Representative	Contractor
_____	_____
Signature	Signature
_____	_____
Date	Date

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SECTION 230100 - HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the work necessary for the heating, ventilating, and air conditioning system, complete. The HVAC General Requirements, Section 230000, is to be included as a part of this section of the specifications.

1.2 CODES & STANDARDS

A. The heating, ventilating, and air conditioning system shall be installed in accordance with the latest edition of the following codes and standards:

1. International Mechanical Code (IMC)

2. International Building Code (IBC)

3. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

4. National Fire Protection Association (NFPA)

5. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS AND APPURTENANCES

A. Packaged Rooftop Air Conditioning Unit:

1. General:
   a. The packaged unit shall consist of condensing section, evaporator section, heating section, blower, filter, and controls, all contained in weatherproof casing suitable for installation on the roof. The entire unit is to be factory wired, piped, and tested. Unit shall bear the UL label for the intended application.

2. Casing:
   a. Casing shall consist of welded steel reinforced framework with 18-gauge zinc grip steel finished with weatherproof baked enamel paint. Cooling section shall be insulated with minimum 1" thick, 1.5 density coated sound absorbing insulation. Easily removable panels shall be provided for access to internal components.

3. Condensing Section:

a. Condensing section shall include spring mounted hermetic compressors; air cooled condenser and fans, evaporator coil, and refrigeration piping and specialties. Compressors shall be furnished with current and temperature overload protection, oil sight glass, and shall carry a 5-year guarantee. Condenser fans shall be upflow propeller type with direct or belt drive motors with overload protection. Propeller fans shall be coated with weather resistant finish and protected by fan guard. Evaporator coils shall be direct expansion coils complete with thermostatic expansion valves. Furnish galvanized drain under coil. Refrigerant piping system shall be completely factory piped with a full operating charge of R-410a. Suction line to be insulated. Units shall be furnished with low ambient control, for operation down to 0 degrees F (not required on units furnished with economizers).

4. Gas Heating Section:
   a. Gas heating section shall be AGA certified and include gas fired furnace with steel heat exchanger and burners, power vent, manual main and pilot shutoff valves, automatic gas valve, electronic ignition, and flame proving controls. Entire unit shall be tested and certified for operation down to -30 degrees F. outdoor temperature.

5. Blower:
   a. Blower section shall consist of heavy duty, centrifugal blower wheels, balanced to eliminate vibration. Furnish adjustable motor mount and v-belt drive. Motors shall be furnished with overload protection.

6. Filters:
   a. Filter frames shall be metal and accommodate the BSD filter media. See equipment schedule for additional information and requirements.

7. Control Section:
   a. Controls shall be as noted on the plans.

8. Manufacturer, Capacity and Accessories:
   a. See drawings.

2.2 HEAT GENERATION

A. Condensing High Efficiency Boilers

1. General:
   a. Quality Assurance
      1) Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
         a) The Terms “Listed” and “Labeled”: As defined in NFPA 70, Article 100.
         b) Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” as defined in OSHA Regulation 1910.7.
      2) ASME Compliance: Boilers shall bear ASME “H” stamp and be National-Board listed.
      3) FM Compliance: Control devices and control sequences according to requirements of FM.

4) Comply with NFPA 70 for electrical components and installation.
5) IRI Compliance: Control devices and control sequences according to requirements of IRI (GE GAP).
6) CSD-1.
7) SCAQMD Rule 1146.1 & 1146.2 for low NOx equipment.

2. Warranty:
   a. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents. Installing contractor shall provide one year of warranty parts and labor.
   b. Special Warranty: Submit a written warranty, executed by the contractor for the heat exchanger.
      1) Warranty Period: Manufacturer's standard, but not less than 10 years from date of Substantial Completion on the heat exchanger. Warranty shall be non-prorated and not limited to thermal shock. Additional 21 year thermal shock warranty on heat exchanger.
         Standard Warranty is pro-rated after 5 years for commercial products.

3. Manufacturers:
   a. Available Manufacturers: Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum five (5) years' experience. Subject to compliance with requirements, manufacturers offering boilers that may be incorporated into the Work include, but are not limited to, the following:
   b. Design: Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for a minimum of 5:1 continuous turn down with constant CO2 over the turndown range. The boiler shall operate with natural or propane gas and have a CSA International certified input rating as noted on the drawings, and a thermal efficiency rating up to 99% at minimum input. The boiler shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The boiler will automatically adjust input for altitude and temperature induced changes in air density. The boiler will use a proven pilot interrupted spark ignition system. The boiler shall use a UL approved flame safeguard ignition control system using UV detection flame sensing. The UV detector shall be air cooled to prevent condensate formation and so designed as to prevent misalignment. The design shall provide for silent burner ignition and operation. The boiler shall be down fired counter flow such that formed condensate always moves toward a cooler zone to prevent re-evaporation. An aluminum corrosion resistant condensate drain designed to prevent pooling and accessible condensate trap shall be provided. A means of neutralizing the condensate Ph levels shall be required. Boiler shall be able to vent a horizontal distance of 80 equivalent feet with a vent diameter equivalent to the combustion chamber outlet diameter.
   c. Service Access: The boilers shall be provided with access covers for easily accessing all serviceable components. The boilers shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All accesses must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.
   d. Indicating lights: Each boiler shall include a diagnostic control panel with a full text

display indicating the condition of all interlocks and the BTUH input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.

4. Components
   a. Combustion Chamber: The combustion chamber shall be constructed of cast-iron. It shall be a down-fired design utilizing light weight refractory around the burner housing.
   b. Heat Exchanger: Boilers shall be a cast iron sectional unit designed for pressure firing and shall be constructed and tested for 100 P.S.I water working pressure, in accordance with the A.S.M.E. Section IV Rules for the Construction of Heating Boilers. Individual sections will have been subjected to a hydrostatic pressure test of 250 PSIG at the factory before shipment and they shall be marked, stamped or cast with the A.S.M.E. Code symbol. Boilers with less than 250-psi pressure test will not be acceptable for this project. The sections shall be of a down fired counter flow single-pass design. Water ports will be sealed with steel push nipple connectors. The sections will be fully machined for metal-to-metal sealing of the gas side surfaces. The design will provide for equal temperature rise through all sections. The iron shall have a minimum thickness of 1⁄4". The heat exchanger design should have no limitations on temperature rise or restrictions to inlet water temperature.
   c. Jacket: Durable Insulated SS
   d. Gas Burner: The burner shall be metal fiber mesh construction, allowing high turndown of the fuel-air mixture. The burner flame shall burn horizontally and be of the pre-mix type with a forced draft fan. Burner shall fire to provide equal distribution of heat throughout the entire heat exchanger. The burner shall be easily removed for maintenance without the disruption of any other major component of the boiler. A window view port shall be provided for visual inspection of the boiler during firing. The gas distribution components and burner shall be enclosed with a cast-aluminum housing.
   e. Ignition components: The ignition hardware shall consist of Alumina ceramic insulated ignition electrodes and UV sensing tube permanently arranged to ensure proper ignition electrode and UV alignment.
   f. Rated Capacity: The boiler shall be capable of operating at rated capacity with gas pressures as low as 3" W.C. at the inlet to the burner gas valve.
   g. The burner shall be capable of 99% efficiency without exceeding a NOx reading above 11ppm.
   h. The burner and gas train shall be provided with the following trim and features:
      1) Burner Firing: Full modulation with 5:1 turndown @ Continuous CO2
      2) Burner Ignition: Intermittent spark
      3) Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, and allow gas valve to open.
      4) Flue-Gas Collector: Enclosed combustion chamber with integral combustion-air blower and single venting connection.
      5) Gas Train: Manual ball type gas valves (2), main gas valve (solenoid), manual test and check valves, pilot gas pressure regulator, and automatic pilot gas valve. All components to be factory mounted and CSD-1 compliant.
      6) Safety Devices: Low gas pressure switch, air-flow switch, and blocked flue detection switch, low water cutoff (manual reset), high temperature manual

reset. All safeties to be factory mounted.

7) Individual gas regulator provided by factory, shipped loose for field installation, one per boiler.

5. Boiler Trim:

a. Controls: The boiler control package shall be a MTI HeatNet or equivalent, integrated boiler management system. The control system must be integral to each boiler, creating a control network that eliminates the need for a "wall mount" stand-alone boiler system control. Additional stand-alone control panels, independent of a Building Management System (BMS), shall not be allowed to operate the boiler network.

The HeatNet control shall be capable of operating in the following ways:

1) As a stand-alone boiler control system using the Heat-Net protocol, with one "Master" and multiple "Member" units.
2) As a boiler network, enabled by a Building Management System (BMS), using the Heat-Net protocol, with one "Master" and multiple "Member" units.
3) As "Member" boilers to a Building Management System (BMS) with multiple input control methods.
4) Failsafe mode – When a Building Automation System is controlling set point, if communications are lost, the boiler/system will run off the Local set point.
5) Adaptive Modulation – Lowers the modulation rate of all currently operating boilers before a newly added boiler enters operation.
6) Priority Firing – Allows mixing of condensing, non-condensing base-load and/or other combination of (2) functional boiler types utilizing (2) priority levels.
7) Available priority start/stop qualifiers shall be done using any combination of: A) Modulation Percentage B) Outdoor Air Temperature or C) Return Water Temperature.
8) Base Loading – Provides the ability to control (1) base load boiler with enable/disable and 4-20mA modulating signal (if required

b. Safety-Relief Valve: ASME rated, factory set to protect boiler and piping as per schedule/drawings. 100 psi maximum allowable working pressure.

c. Gauge: Combination water pressure and temperature shipped factory installed. LCD outlet temperature readout to be an integral part of the front boiler control panel display to allow for consistent easy monitoring of temperatures factory mounted and wired.

d. Burner Controls: Boiler shall be provided with a Honeywell RM7800 series digital flame safe guard with UV rectification. The flame safe guard shall be capable of both pre and post purge cycles.

e. High Limit: Temperature control with manual-reset limits boiler water temperature in series with the operating control. High Limit shall be factory mounted and sense the outlet temperature of the boiler through a dry well.

f. PROVIDE THE FOLLOWING STANDARD TRIM:

1) Aluminum Condensate Receiver Pan
2) Low Air Pressure Switch
3) Blocked Flue Detection Switch
4) Modulation Control
5) Temperature/Pressure Gauge
6) Manual Reset High Limit

7) Low Gas Pressure Safety Switch
8) Low Water Cutoff with Manual Reset (CSD-1 Factory mounted and wired))
9) Gas Pressure Regulator to provide 6" Incoming Pressure to Main Gas Valve – Shipped Loose for Field Installation.
10) Air inlet filter
11) Supply Outlet Temperature Display
12) Full Digital Text Display for all Boiler Series of Operation and Failures
13) Variable Frequency Drive (not required on KN-26 & 30) and Combustion Air Fan with Safety Interlock
14) Condensate Drain
15) High Gas Pressure Switch and Valve Proving Switch for IRI Compliant GasTrain.
16) Flow Switch mounted and wired.
17) Isolation Valve wiring with mounted J box in rear of boiler.
18) Pump relay mounted and wired.

6. Motors:
   a. Boiler Blower Motor: Blower motor shall be externally mounted for ease of service. There shall be no requirement to remove covers or gas train components to remove the blower motor.

7. Source Quality Control:
   a. Test and inspect boilers according to the ASME Boiler and Pressure Vessel Code, Section IV. Boilers shall be test fired in the factory with a report attached permanently to the exterior cabinet of the boiler for field reference.

8. Examination:
   a. Examine area to receive boiler for compliance with requirements for installation tolerances and other conditions affecting boiler performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

9. Installation:
   a. Install boilers level and plumb, according to manufacturer's written instructions and referenced standards.
   b. Install gas-fired boilers according to NFPA 54.
   c. Install electrical devices furnished with boiler, but not specified to be factory mounted.

10. Connections:
    a. Connect gas piping and individual regulator, full size, to boiler gas-train inlet with union.
    b. Connect hot water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.
    c. Install piping from safety-relief valves to nearest floor drain.
    d. Connect breeching to boiler outlet, full size of outlet. The boiler shall operate under positive (Category IV) or negative (Category II) stack pressure. Vent material must be listed UL 1738 Stainless Double Wall Stack for condensing appliances.
    e. Electrical: Comply with applicable requirements in the electrical specifications.
    f. Ground equipment.

1) Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

11. Field Quality Control:
    a. Manufacturer's Field Service: Engage a factory-authorized service representative to supervise the field assembly of components and installation of boilers, including piping and electrical connections. Report results in writing.
        1) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Boiler shall be commissioned by factory authorized technician. Contact local representative for factory authorized technician information.
    b. Manufacturer's representative shall supply a factory authorized service technician to start up the boilers.

12. Cleaning:
    a. Flush and clean boilers on completion of installation, according to manufacturer's written instructions.
    b. After completing boiler installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions with manufacturer's stainless-steel polish.

13. Start Up
    a. Engage a factory-authorized service representative to provide startup service. Start up to be performed only after complete boiler room operation is field verified to offer a substantial load, and complete system circulation. One-year warranty shall be handled by factory authorized tech.
    b. Complete manufacturer's installation and startup checklist are complete.

2.3 PLATE AND FRAME HEAT EXCHANGER

1. Design:
    a. To reduce installation and maintenance cost, units should be designed as single pass units unless thermal and hydraulic conditions require multi-pass arrangement.
    b. For single pass units all connections should be located on the fixed head, frame plate, allowing the movable head, pressure plate, to slide back and plates added, removed, or replaced from the plate pack without disturbing the connections or associated piping.
    c. The design should allow for the removal of interior plates without the removal of the preceding plates.
    d. The unit shall be designed and hydro-tested in accordance with People's Republic of China National Standard GB 16409 – 1996.

2. Frame:
    a. The frame plate and pressure plate should be carbon steel in accordance with GB 16409.

b. The frame and pressure plate shall be of sufficient thickness to meet the GB 16409 design pressure. Stiffeners or support brackets are not allowed.
c. Carbon steel frame components shall be painted with gray epoxy paint.
d. Units with 3-inch or greater connections shall be unlined or alloy lined studded ports to mate with raised face or flat faced flanges. Rubber liners are not allowed.
e. Units with 2 or 2 1/2-inch connections shall have carbon steel female tapped or male tapped connections if an alloy material is required.
f. Units with 1-inch ports shall have carbon steel or 316 stainless steel female tapped or alloy material male tapped connections.
g. Units with connections greater than 50mm (2-inch) require that the thermal plates be supported by the carry bar, top bar. The guide bar, bottom bar, shall only help properly align the plates.
h. The pressure plate shall be supported by a roller assembly from the carry bar for units with 65mm (2 1/2-inch) or greater port sizes.
i. The carry and guide bar plate contact surfaces shall be corrosion resistant.
j. The design for units with 2-inch connections or smallerallow the plates be supported by the guide bar, bottom bar, and the carry bar, top bar, shall help properly align the plates. Carry and guide bars are to be steel with a zinc chromate coating.

3. Tightening Bolts:
   a. Tightening bolts shall comply with GB 16409.
   b. The tightening bolt assemblies shall include captive working nuts at the pressure plate, rear head, such that the unit can be opened and closed with one wrench from the front of the unit.

4. Plates:
   a. Plates shall be pressed in a one step stamping process.
   b. Plates shall use an integral rolled edge hanging system to provide a rigid hanger device between the plate and carry bar and guide bar. Welded on hanging brackets or stiffeners are not acceptable.
   c. The plate pack shall use a positive plate to plate alignment system to ensure proper plate to gasket seals throughout the plate pack. The positive alignment system shall either be a gasket lug which fits within a plate recess on the proceeding plate (tongue in groove) to align successive plates or an extended rolled edge hanger which nests successive plates through direct contact around the entire plate hanger. Plate designs, which only offer alignment through contact with the carry and guide bar, are unacceptable.
   d. Plates shall be permanently marked to indicate plate material and thickness.

5. Gaskets:
   a. All gaskets except the gasket on the first plate shall be identical.
   b. The gaskets shall be a one-piece construction with a double gasket barrier at the port region. The area isolated by the double gasket shall be vented to the atmosphere, so that a gasket failure is detected by leakage to the exterior prior to any possible cross contamination.
   c. Gasket attachment methods, which break during gasket removal or plate maintenance thus destroying the gasket, are not allowed.
   d. Care should be taken in the selection of gasket materials to insure compatibility with the fluids and operating temperatures.

6. Thermal/Hydraulic Design, Certification and Testing:
   a. The manufacturer shall provide written guarantee to the accuracy of the heat exchanger thermal design.
   b. The manufacturer shall be certified with the Air-Conditioning and Refrigeration Institute's Liquid to Liquid Heat Exchanger Certification program ARI Standard 400 for the Model being supplied.
   c. Should the Heat Exchanger not perform to the specified conditions as defined in the ARI Standard 400, the manufacturer is responsible to replace or repair the exchanger to achieve the stated performance.
   d. If the manufacturer is not certified with the Air-Conditioning and Refrigeration Institute's Liquid to Liquid Heat Exchanger certification program ARI Standard 400, a witnessed factory performance test must be completed per the testing specification of ARI 400.

2.4 REFRIGERATION

A. Ductless Split System - Wall-Mounted Units
¾ to 3 ton nominal cooling only or heat pump outdoor unit

1. General:
   a. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware. Unit shall be rated per ARI Standards 210/240 and UL labeled.

2. Unit Cabinet:
   a. Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.

3. Fans:
   a. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
   b. Air sweep operation shall be user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.

4. Coil:
   a. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap.

5. Motors:
   a. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.

6. Controls:

a. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 62° F to 84° F.
b. The unit shall have the following functions as a minimum:
    1) An automatic restart after power failure at the same operating conditions as at failure.
    2) A timer function, to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
    3) Temperature-sensing controls shall sense return air temperature.
    4) Indoor coil freeze protection.
    5) Wireless infrared remote control to enter set points and operating conditions.
    6) Automatic air sweep control to provide on or off activation of air sweep louvers.
    7) Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.
    8) Fan-only operation to provide room air circulation when no cooling is required.
    9) Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.
    10) Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.
    11) Automatic heating-to-cooling changeover in heat pump mode. Control shall include deadband to prevent rapid mode cycling between heating and cooling.
    12) Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.

7. Filters:
    a. Unit shall have filter track with factory-supplied cleanable filters.

8. Electrical Requirements:
    a. Power is supplied from outdoor unit.

9. Special Features (Field Installed, if necessary):
    a. Condensate Pump: The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts; an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. A liquid level sensor in the reservoir shall stop cooling operation if the liquid level in the reservoir is unacceptable.

10. Warranty:
    a. Minimum 1-year parts limited warranty.

11. Outdoor Units:
    ¾ to 3 Ton Nominal Cooling Capacity / ¾ to 3 Ton Nominal Heating Capacity
    a. General:
        1) Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the compressor.
        2) Units shall consist of a rotary compressor, an air-cooled coil, propeller-type draw-through outdoor fan, reversing valve (HP), accumulator (HP units),

metering device(s), and control box. Units shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to-air cooling only, or heat pump system.

3) Units shall be used in a refrigeration circuit matched to duct-free cooling only or heat pump fan coil units.

b. Unit Cabinet:
   1) Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish on inside and outside.
   2) Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
   3) Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

c. Fans:
   1) Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall draw air through the outdoor coil.
   2) Outdoor fan motors shall be totally-enclosed, single phase motors with class B insulation and permanently-lubricated ball bearings. Motor shall be protected by internal thermal overload protection.
   3) Shaft shall have inherent corrosion resistance.
   4) Fan blades shall be non-metallic and shall be statically and dynamically balanced.
   5) Outdoor fan openings shall be equipped with PVC metal/mesh coated protection grille over fan.

d. Compressor:
   1) Compressor shall be fully hermetic rotary type.
   2) Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and over-current.
   3) Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.
   4) Compressor assembly shall be installed on rubber vibration isolators.

e. Outdoor Coil:
   1) Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.

f. Refrigeration Components:
   1) Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, reversing valve. Provide tamper proof port caps.

g. Controls and Safeties:
   1) Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:
      a) A time delay control sequence is provided standard through the fan coil board.
      b) Automatic outdoor-fan motor protection.
      c) System diagnostics.
      d) Compressor motor current and temperature overload protection.
      e) Outdoor fan failure protection.

h. Electrical Requirements:
   1) Unit electrical power shall be a single point connection.
   2) Unit control voltage to the indoor-fan coil shall be 24 VDC.
   3) All power and control siring must be installed per NEC and all local electrical codes.
   4) Unit shall have high-and low-voltage terminal block connections.

i. Special Features (Field Installed):
   1) Low-Ambient Kit: Control shall regulate fan-motor cycles in response to saturated condensing temperature of the unit. The control shall be capable of maintaining a condensing temperature of 100° F ± 10° F, with outdoor temperatures to 20° F. Installation of kit shall not require changing the outdoor fan motor.
   2) Crankcase Heater.

j. Warranty:
   1) 1-Year parts and 5-Year compressor warranty.

2.5 EXHAUST FANS

A. Kitchen Hood Exhaust (up-blast)

1. Description:
   a. Fan shall be a spun aluminum, roof mounted, belt driven, up-blast centrifugal exhaust ventilator.

2. Certifications:
   a. Fan shall be listed by Underwriters Laboratories (UL 762) and UL listed for Canada (Power Ventilator for Restaurant Exhaust Appliances). Fan shall bear the AMCA certified ratings seal for sound and air performance.

3. Construction:
   a. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The windband shall have a rolled bead for added strength. A wiring compartment with chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.

4. Wheel:
   a. Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96.

5. Motor:
   a. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and

furnished at the specified voltage, phase and enclosure.

6. Bearings:
   a. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a pillow block housing selected for a minimum L10 life in excess of 100,000 hours at maximum cataloged operating speed.

7. Belts and Drives:
   a. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

8. Manufacturer, Capacity & Accessories:
   a. See Drawings.

B. Ceiling Cabinet Exhaust Fan (Standard):

1. Description:
   a. Fan shall be ceiling, wall, or inline mounted, direct driven, centrifugal exhaust fan.

2. Certifications:
   a. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

3. Construction:
   a. The fan housing shall be minimum 20 gauge galvanized steel and acoustically insulated housing above 200 cfm. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel and shall be easily removable from the housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A powder painted white steel grille shall be provided as standard.

4. Wheel:
   a. Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard.

5. Motor:
   a. Motor shall be open drip proof type with permanently lubricated sealed bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage.

6. Manufacturer, Capacity & Accessories:

a. See Drawings

2.6 PUMPS

A. Base Mounted Centrifugal Pumps

1. General – Pumps shall be base mounted, single stage, end suction design with true back pull-out, capable of being serviced without disturbing the piping connections, electrical motor connections or the pump-to-motor alignment. The pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet. The volute shall be supplied with plugged vent, drain and gauge tappings. The pump casing shall be Class 30 cast iron, suitable for 175 PSI working pressure. Flanges shall be ANSI 125 PSI.

2. The pumps shall be sized for a non-overloading condition, whether it is a single pump installation, lead-lag installation or parallel pumping installation. In a parallel installation, one pump must be able to operate in a non-overload condition while the other pump is turned off. The pump submittals must show this situation, complete with parallel pumping and system curves.

3. The dimensions of the suction and discharge connections of each pump shall not be less than those of the scheduled pumps shown on the plans.

4. Impeller – The impeller shall be a cast bronze, enclosed type, dynamically balanced to ANSI grade G6.3. The impeller shall be keyed to the shaft and secured by a locking capscrew.

5. Seal – The internal cavity shall be sealed off at the pump shaft by an internally –flushed mechanical seal with ceramic seat and carbon seal ring, suitable for continuous operation at 225^{o}F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal. The seal shall be capable of being serviced without disconnecting the pump from the piping.

6. Bearings – The pump bearings shall be of the re-greasable camlock ball bearing type with provisions for purging or flushing through the bearing surface, and capable of being inspected by removing the bearing covers. The pump shaft shall be constructed of 18-8 stainless steel.

7. Coupling – A flexible type, center drop-out design coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed applications shall be furnished with an EPDM coupler sleeve. The coupling shall be shielded by an OSHA rated coupling guard, complete with inspection windows for viewing of the coupler.

8. Motor – The motor shall meet NEMA and EPACT ’92 specifications and shall be of the size, voltage and enclosure called for on the plans. The pump and motor shall be factory aligned, and shall be realigned by a factory approved motor alignment company. The motor alignment company shall be approved by the Engineer prior to alignment. A copy of the final alignment shall be included on the O&M manuals.

9. Base – The pump and motor shall be mounted on a common baseplate, constructed of structural steel, with fully enclosed sides and ends, and securely welded cross members. The grouting area shall be fully open. The combined pump and motor baseplate shall be sufficiently stiff as to limit the susceptibility of vibration. The minimum baseplate stiffness shall conform to ANSI/HI 1.3.4-1997 for Horizontal Baseplate Design standards.

2.7 AIR DISTRIBUTION

A. Ductwork:

1. Low pressure ductwork shall be fabricated from galvanized sheet metal, unless otherwise indicated. Construction requirements shall be in accordance with SMACNA - HVAC Duct Construction Standards, metal and flexible, latest edition. All sheet metal ductwork shall be sealed with McGill United Sheet Duct Sealer or equal, in accordance with the International Energy Compliance Code, latest edition. Adjustable (twist) elbows are not allowed. Low pressure ductwork shall be constructed to the following SMACNA static pressure standards:
   a. Supply air ductwork = 2" W.G.
   b. Return, Exhaust, Outside Air Intake ductwork = 1" W.G.

1. Low pressure ductwork located exposed in exposed ceiling areas, shall be spiral type ducts with a “paint-grip” finish, on ductwork and associated fittings that can be painted. Joints shall be sealed evenly and in a professional manner with silver silicon. Discolored or damaged ductwork unacceptable to the Engineer shall be replaced at the Contractors expenses.
   a. Joints: 0” to 20” diameter, interior slip coupling beaded at center, fastened to duct with screws and with sealing compound applied continuously around joint before assembling and after fastening. Sealing compound shall be applied in an evenly and professional manner.
   b. Joints 22” – 72” diameter, use 3-piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Manufacturer shall be Ductmate Spiralmate or equal.
   c. All takeoff or branch entrances shall be by means of factory-fabricated fittings. Field taps shall not be allowed.

2. Low pressure ductwork which is exposed or located in mechanical rooms shall be fabricated from galvanized sheet metal. Construction requirements shall be in accordance with SMACNA HVAC Duct Construction Standards, metal and flexible, latest edition.

3. Type – 1 Kitchen Hood exhaust ductwork shall be fabricated from minimum 16 gauge welded steel, and shall be constructed in strict accordance with the latest edition of the International Mechanical Code.

   Type – 2 Kitchen Hood exhaust ductwork shall be fabricated from aluminum sheet metal, in accordance with SMACNA Standards

4. Ductwork penetrating protective elements of fire-rated corridor walls, with no openings into corridor, shall be constructed of minimum 26 gauge galvanized steel.

5. Exterior exposed ductwork shall be fabricated from galvanized sheets. All joints and seams shall be standing-seam type with sealing mastic to provide watertight construction. All ductwork shall be internally insulated as hereinafter specified. All exposed surfaces shall be primed and painted two coats of exterior enamel paint, color as selected by the Architect.

6. Shower and locker room exhaust ductwork shall be constructed of galvanized sheet metal, in accordance with SMACNA standards.

7. Flexible ducts shall be listed per UL-181 standard as Class 1 flexible, acoustical insulated air duct and complying with NFPA Standards 90A and 90B. Ducts shall be insulated with a minimum R-5 value, and shall have a maximum vapor transmission value of .05 perms. Ducts shall be factory made with and composed of: a PE liner duct permanently bonded to a coated spring steel wire helix. Duct shall be chlorine free and carry a ten-year warranty for the labor to replace the duct should there be a factory defect. Low permeability outer vapor barrier of fiberglass bidirectional reinforced metalized laminate shall complete the composite. Pressure rating shall be 6" w.g. and maximum length shall be 6 feet. Attach to duct take-off, diffuser, register, or grille only, with nylon or stainless steel duct clamp or tie. Flexmaster 1-M, or approved equal.

B. Duct Accessories:

1. Turning vanes shall be installed in all rectangular or square elbows. Vanes shall be installed in vane side rails. Vanes shall be single wall vanes, and be fabricated and installed per SMACNA standards.

2. Volume dampers shall be fabricated from galvanized steel in accordance with SMACNA standards. Dampers shall have a continuous galvanized steel shaft on ducts 13” diameter or larger, with damper regulators and end bearings. Dampers located above inaccessible ceilings (hard ceilings) shall be furnished with concealed ceiling damper regulators. Dampers shall be pressure rated equal to the design duct pressure rating. Dampers shall be provided at all diffuser and supply/exhaust grille takeoffs, regardless if indicated on the plans. Dampers are not required on the return air takeoffs unless specifically indicated.

3. Flexible connections shall be provided at all rotating fan equipment. Connectors shall be of fire, water, and weather resistant material.

4. Fire dampers shall be UL-labeled with frame, locking assembly, accordion style folded blades, and fusible link. Dampers shall be Style B with blades stored outside of the air stream. Provide duct inspection door at each fire damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel.

5. Combination smoke and fire dampers are to be fusible link type with factory sleeve and electric operator located exterior to duct 120 V. operator to be spring return, fail closed with 212 degrees F link and UL label. Provide duct inspection door at each damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel. Belimo operators/actuators only.

6. Smoke dampers are to be ultra-low leakage (less than 4CFM/ft^2) type with factory sleeve and electric operator located exterior to duct 120 V. operator to be spring return, fail closed and UL label. Provide duct inspection door at each damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel. Belimo operators/actuators only.

7. A plastic flex elbow support by Flexible Technologies Inc., Titus FlexRight, or approved equal, is required at all flex duct elbows supplying ceiling diffusers & return grilles. Elbow support shall be fully adjustable, or be of universal design, to support flexible diameters 6" – 16", sized to fit flex duct. Elbow supports shall be UL rated for use in return air plenum spaces. At the Contractor's option, a hard elbow may be used in lieu of a flexible elbow.

C. Diffusers, Registers, Louvers, Grilles, Weathercaps:

1. See Drawings for requirement.

D. Duct Cleanliness:

1. Ductwork Delivery To Site
   a. During ductwork being delivered from the premises of the manufacturer, care must be taken to prevent damage during transportation and off-loading.

2. Temporary Storage
   a. Job site duct material storage areas should be clean, dry, and located away from high dust generating processes such as masonry or tile cutters, cutoff saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept. The general contractor should designate a suitable area for temporary storage.
   b. To prevent ductwork material damage from standing water, storage locations should include pallets or blocking to keep fabricated metal ductwork above the floor surface. If there is a risk of water runoff from above or dusty areas cannot be avoided, coverage should be used to protect stored materials.

3. Installation
   a. Before the installation of individual duct sections, they are to be inspected to ensure that they are free from all debris.
   b. All ductwork risers must be covered to prevent the entry of debris into the duct.
   c. Downward facing and horizontal ductwork openings will not be required to be covered.
   d. Access covers shall be firmly fitted in position on completion of each section of the work. Open ends on completed ductwork and overnight work-in-progress shall be sealed.
   e. The working area should be clean and dry and protected from the elements.
   f. The internal surfaces of the uninsulated ductwork shall be wiped to remove excess dust immediately prior to installation.

2.8 PIPING SYSTEMS

A. Condenser Water Piping and Fittings:

1. Piping shall be standard weight (schedule 40), ASTM A53 black steel pipe with 125 pound black, screwed or welded, malleable iron fittings.

2. At the contractor's option Victaulic, Shurjoint, or Anvil Gruvlock grooved, schedule 40, black steel piping with ASTM A536 ductile iron; ASTM A234 forged steel; or ASTM A53 fabricated steel fittings and couplings may be used. Carbon Steel, A-53B/A-106B with roll grooved-ends may be used in lieu of welded systems. Grooved products must conform to ASTM A536 ductile iron may be used. Carbon Steel, A-538/A-1068 – Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressure, size and method of joining. Pipe ends to be grooved in accordance with the current listed standards conforming to ANSI/AWWA C-606.

   Grooved Mechanical Couplings

   Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi.
   a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI 831.1, 831.9, and NFPA 13.
      1) 2" through 12": Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C) without the need for high temperature lubricants. Basis of design: Victaulic Style 107 or approved equal.
   b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used inlieu of flexible connectors at pump connections. Three couplins for each connector shall be placed in close proximity to the vibration source. Please note this applies only to pumps and not other pieces of equipment.
      1) 2" through 8": Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C) without the need for high temperature lubricants. Basis of design: Victaulic Style 177.
      2) 10" through 12": Standard flexible couplings. Gasket shall be Grade "E" EPDM compound with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).

3. At the contractor's option, piping may be Type L hard drawn copper, ASTM B88. Fittings shall be cast brass, ANSI/ASME B16.23, or solder wrought copper, ANSI/ASME B16.29. Joints shall be ASTM B32 solder, grade 95TA.

   At the contractor's option copper tube may be installed with grooved mechanical joints in lieu of soldering. 2"-8" for copper tubing consisting of ductile iron cast housings, complete

with a synthetic rubber gasket of a pressure-responsive design, with plated nuts and bolts to secure unit together. Couplings shall be manufactured to connect copper tubing sized tube and fittings. (Flaring of tube and fitting ends to IPS dimensions is not allowed).

a. Coupling Housings: Ductile iron conforming to ASTM A-536, Grade 65-45-12, coated with copper colored alkyd enamel. Housings cast with offsetting, angle-pattern bolt pads to provide rigidity.
b. Coupling Gaskets: Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures form -30 deg F to +250 deg F.
c. Basis of design: Victaulic Style 607.

4. Piping underground or below slab shall be Schedule 80 PVC, ASTM D1785 or D2241. Fittings shall be PVC, ANSI/ASTM D2466. Joints shall be solvent weld, ASTM D2855, or gasketed, ASTM F477. Piping shall be rated for not less than 150 psig pressure.

B. Refrigerant Piping:

1. Refrigerant piping shall be manufacturer's standard line sets, in lengths as required for proper installation. Coiling of excess tubing will not be acceptable.

2. Provide factory wall outlet Airex Titan Outlet by Airex Manufacturing Inc. or equal. Wall outlet shall be provided with compression gasket and seal and fastened with non-corrosive screws with pre-loaded neoprene washers. Wall outlet shall be provided with an integrated over-molded flexible elastomeric sleeve for sealing, isolating and supporting refrigerant pipes from vibration. The wall outlet must provide for expansion and contraction wall protection features with gaskets and seals. A stainless-steel clamp must be provided and installed to provide a watertight seal.

C. Condensate Drain Piping:

1 Exterior: Piping shall be Schedule 40 PVC. A union shall be installed directly at the roof top equipment for ease of replacement in the future. All piping connections shall be friction fit only, no glue. Provide trap in accordance with manufacturer's requirements.

3 Interior: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, or may be Schedule 40 PVC. Copper piping shall not be used on 90% condensing type equipment. Provide a neoprene or rubber gasket at all copper piping support hangers to inhibit corrosion. Provide trap in accordance with manufacturer's requirements.

1. Inside Mechanical Rooms: On all non-condensing systems, piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, for durability reasons.

D. Pipe Hangers and Supports:

1. See Section 220000 for hanger and support requirements for piping systems.

E. Piping Accessories:

1. Piping Hydronic Thermometer: Thermometer shall be 3" bimetal dial thermometers with recalibrator with a 0°F to 250°F range and 2°F scale and accurate within 1% of scale range.

Thermometer shall be provided with an Vari-angle Form angle stem and thermowell. Thermometers shall be installed in the hydronic system in a neat workman like manner, aligned vertically and horizontally with other thermometers in the system. The thermometers shall be installed no higher than 9'-0" above finish floor and be readable from finish floor. Weiss instrument or approved equal.

2. Piping Hydronic Pressure Gauges: Pressure gauges shall be 4½" diameter, liquid filled gauges with ranges to meet 1.5 times the pressure ratings of the system its serving. Pressure gauges shall be provided with quarter turn ball valve isolation valves on the source side and on the bleed off line. Pressure gauges shall be installed in the hydronic system in a neat workman like manner, aligned vertically and horizontally with other pressure gauges in the system. The pressure sensors shall be installed no higher than 9'-0" above finish floor and be readable from finish floor. Weiss instrument or approved equal.

3. Air Vent: Non-modulating, high capacity, automatic type designed to purge free air from the system and provide positive shutoff at pressures up to 150 psig at a maximum temperature of 250°F. Vent shall be constructed of cast iron body and bonnet with stainless steel, brass, EPDM, and silicon rubber internal components.

J. Valves:

1. See Section 220000 for valve requirements.

K. Grooved Piping Requirements:

1. Grooved Pipe Valves:
   a. Butterfly Valves – 2" through 12" Sizes: 300 psi CWP suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree circumferential seating. Seat shall be pressure responsive EPDM. Basis of design: Victaulic Vic®-300 MasterSeal™ or approved equal.
   b. Check Valves – 2" through 3" Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, stainless steel non-slam tilting disc, stainless steel spring and brass shaft, nickel-plated seat surface, 365 psi. Victaulic Series 716H / 779 or approved equal.
   c. General Duty Valves – Tri-Service Valve Assembly: Combination shut-off, throttling and non-slam check valve.
      1) 2-1/2" through 12" Sizes: Butterfly valve with memory stop feature assembled with spring assisted, non-slam check valve. Check valve may include venture-like taps for flow measurement. Working pressures to 300 psi. Basis of design: Victaulic Series 761 butterfly valve in combination with Victaulic series 716 or 779 Check valve or approved equal.

2. Grooved Pipe Specialties:
   a. Strainers – Grooved-End
      1) T-Type Strainer: 2" through 12" sizes, 300 PSI T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-14-12) body, Type 304 stainless steel

frame and mesh removable basket with No. 12 mesh, 2”-3” strainer sizes, or No. 6 mesh, 4”-12” strainer sizes, 57% free open area. Basis of design: Victaulic Style 730 / W730 or approved equal.

2) Y-Type Strainer, 2” through 18” sizes, 300 PSI, Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16” (1,6mm) diameter perforations 2”-3” strainer sizes, 1/8” (3.2mm) diameter perforations 4”-12” strainer sizes, and 0.156” (4mm) diameter perforations 14”-18” basis of design strainer sizes. Basis of design: Victaulic Style 732 / W732 or approved equal.

b. Suction Diffuser – Flanged outlet with grooved inlet connections, rated to 300 psi. Ductile iron (ASTM A-536) body, 304 stainless steel frame and perforated sheet diffuser with 5/32” (4,0mm) diameter holes. Removable 20 mesh 304 stainless steel start-up pre-filter, outlets for pressure/temperature drain connections, and base support boss. Basis of design: Victaulic Series 731-G and W731-G or approved equal.

3. Quality Assurance
   a. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by one manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

4. Execution:
   a. Installation:
      1) Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing.
      2) The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
      3) Couplings installation shall be complete when visual metal-to-metal contact is reached.
   b. Training:
      1) A factory trained representative (direct employee) of the grooved product manufacturing company shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and product installation.
   c. Application:
      1) A representative of the grooved system supplier shall periodically visit the job site and review installation. Contractor shall fix and/or replace any improperly installed products.
      2) Grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods.
      3) All grooved components shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or BOCA.
      4) Grooved end product manufacturer to be ISO-9001 certified.

2.9 PIPING SYSTEMS CLEANING & CHEMICAL TREATMENT

A. Condenser Water Closed Loop Cleaning & Chemical Treatment:

1. The Mechanical Contractor shall fill each hydronic system with clean fresh water prior to

cleaning and thoroughly leak check system piping. A qualified water treatment contractor shall be utilized to furnish the cleaning material and supervise the flushing and treatment of the system. Approved water treatment contractors must show proof of similar service for not less than 3 years, and shall have full-time service personnel located within one hour from the job site. A cleaning and passivating agent supplied by the Chemical Treatment Contractor shall be added to the system at the direction of the Treatment Contractor during the leak check process to minimize initial corrosion. If the system is filled multiple times during the leak check and repair process the Mechanical Contractor shall coordinate with the Treatment Contractor to maintain this initial protection. The Treatment Contractor is responsible for providing chemical for up to two refills of the system. If additional chemical is required due to multiple re-fillings the Mechanical Contractor shall be responsible for the additional time and chemical.

2. The Mechanical Contractor shall close isolation valves at each heat pump and open the bypass valve to prevent flow through the strainer, flow control device and heat pump during the initial flushing and subsequent cleaning. The side stream filter bag shall be removed during the initial flushing process.

3. Following leak check the closed system shall be flushed by the Mechanical Contractor until the leaving water runs clear. All primary runs shall be flushed at their ends to obtain maximum sweep of debris from the system. The inlet screens on the circulating pumps must be kept clear during this initial cleaning process and inspected following cleaning. When flushing is complete the system is to be left full.

4. Prior to flushing the Mechanical Contractor shall coordinate with Treatment Contractor so that the Treatment Contractor can be available immediately following flush to add cleaning chemical within 4 hours to prevent initial corrosion.

5. Following initial flushing the Chemical Treatment Contractor shall refill all systems with cleaning and passivating agents raising the PH to a minimum of 10, circulate for a minimum of 8 hours and flush until thoroughly clean. All primary piping runs shall be flushed at the ends during this cleaning process. The side stream filter bags shall be inspected during cleaning and changed as required. Cleaning shall continue until these bags no longer show signs of debris.

6. Following cleaning process, the Treatment Contractor shall close the bypass valves at each heat pump and open isolation valves for normal operation and check for leaks. The bypass valve handle shall be removed and tied to the valve. A clean bag filter shall be installed in the system.

   The water treatment contractor shall refill system with a mixture of clean water and chemical inhibitor. Add nitrite to system to maintain a nitrite level of 800-1000 ppm. Test for nitrite using a “Drop Test” kit.

7. The Treatment Contractor shall provide final inspection report for inclusion in the Operation and Maintenance Manual. Additionally, the Treatment Contractor shall take loop samples approximately 12 months following completion, add or adjust chemical as required and provide a post construction report to the owner prior to warranty closeout. Chemical required is the responsibility of the Treatment Contractor.

B. Chemical Treatment Station:

1. A chemical treatment station shall be provided by the Treatment Contractor in a 24” x 24” locked cabinet. Station shall include LMI DC4000-1-1 conductivity meter with sensor and A-17-1-1351S chemical pump, or approved equal. The chemical station shall be located inside the mechanical room. Mechanical Contractor shall provide ¾” PVC piping from the discharge of the spray pump of the fluid cooler to the station enclosure with T’s for installation of the conductivity sensor and for chemical injection. Return piping shall be piped back to the fluid cooler sump at the opposite end from the spray pump pickup. The Treatment Contractor shall install the conductivity sensor and injection fitting in the T’s provided and set up initial treatment.

2.10 INSULATION

A. General:

1. All insulation shall have composite fire and smoke hazard ratings, as tested by ASTM E-84, NFPA 255, and UL 723, not exceeding:

Flame Spread	25
Smoke Developed	50

B. Ductwork - External Insulation:

1. Insulation shall be fiberglass insulation with aluminum foil scrim kraft facing. All joints shall be taped with UL listed tape to provide a continuous vapor barrier. The following ducts shall be externally insulated:
   a. Supply ducts in unconditioned spaces (unless internally insulated)
   b. Return ducts in unconditioned spaces (unless internally insulated)
   c. Combustion air ducts
   d. Outside air intake ducts
   e. Exposed ductwork located within conditioned spaces shall not be externally insulated

2. Insulation thickness & "R" values shall be as follows:
   a. R-6 – ducts located in unconditioned spaces (such as above ceiling, but below roof insulation) and outside air intake ducts.
   b. R-12 – ducts located outside of the building's insulation envelope (such as above the attic insulation).

C. Ductwork - Internal Insulation:

1. Insulation shall be flexible fiberglass duct liner. Liner shall be attached with 100% coverage of manufacturers recommended adhesive and welded or mechanically fastened galvanized steel pins. All exposed edges of liner shall be coated with adhesive. Duct dimensions shown are net air side face-to-face of duct liner. The following ducts shall be internally insulated:
   a. Supply and Return ducts within 15'-0" of air handler
   b. Supply and Return ducts in mechanical rooms
   c. 15’-0” downstream of VAV terminal units.

d. 15’-0” downstream of fan coil units.
e. Exterior ducts (located outdoors)
f. Buried ductwork below concrete slab
g. Ducts as indicated on plans

2. Insulation thickness & "R" values shall be as follows:
   a. R-6 – ducts located in unconditioned spaces (such as above ceiling, but below roof insulation, or buried ductwork) and outside air ducts located outside of the building envelope.
   b. R-12 – ducts located outside of the building's insulation envelope (such as above the roof).

D. Piping Insulation - Refrigerant Piping:

1. Insulation on refrigerant suction piping shall be one-piece preformed flexible formed tubing with built-in closed cell vapor barrier. Seal laps and butt joints with moisture resistant adhesive to provide a continuous vapor seal. Cover all insulated suction lines exposed on the exterior of the building with E-Flex Guard by Airex Manufacturing, Inc. At exterior wall penetration provide Titan outlet by Airex Manufacturing, Inc. or equal with an Insulation thickness as follows:

	Nominal Pipe Diameter		
Refrigerant line set type	1” and less	1" to < 1½"	1 ½” and above
Located with-in the conditioned spaces			
Suction	½”	1”	1"
Liquid	not required		
Discharge (hi/low pressure)	1”	1"	1”
Located outside the conditioned spaces			
Suction	½”	1”	1"
Liquid	not required		
Discharge (hi/low pressure)	1 ½”	1 ½”	2”

F. Piping Insulation - Exterior (Outdoor) Piping:

1. Piping located outdoors shall be insulated as specified above. In-addition piping shall be covered with a weather-proof aluminum alloy 3003 or 3105 jacket meeting ASTM standard B209, minimum 0.016” think, installed per the manufacturers installation requirements. At a minimum the following installation shall occur. The jacketing overlap shall be a minimum of 2”. Horizontal piping shall have the jacket seams located at the 3 o’clock or 9 o’clock position with the seam joint openings point downward to shed moisture. Vertical piping shall have the upper jacket seams overlap the lower seam to shed moisture. Valve handles and gauges shall be positioned on the bottom to help prevent water penetration. Banding shall be used to secure the jacketing; screws, rivets, and all other fasteners capable of penetrating the underlying vapor retarder shall be prohibited. Jacketing sealant shall be applied to all longitudinal and circumferential joints and the sealant shall be located between the aluminum jacket, not at the outer lip.

G. VIBRATION ISOLATION

A. General:

1. All rotating equipment and appurtenances connected to rotating equipment shall be vibration isolated from the supporting structure. No metal to metal contact will be permitted between fixed and floating parts. All metal isolators exposed to weather shall be hot dipped galvanized after fabrication. Piping connected to rotating equipment shall be hung with spring hangers for first 50 pipe diameters.

B. Floor Mounted Spring Isolators:

1. Isolators shall be free standing, laterally stable, and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter to operating spring height of 1.0 and an additional travel to solid equal to 50% of rated deflection.

C. Floor Mounted Neoprene Pads:

1. Isolators shall be neoprene waffle or combination neoprene and cork sandwich. Pads shall be sized and selected as per manufacturers loading requirements.

D. Spring Hangers:

1. Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional spring travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.

2.11 SEISMIC SUPPORTS

A. All equipment, ductwork, and piping shall be seismically supported as required by the International Building Code, latest edition.

2.12 CONTROL SYSTEM

A. General:

1. The Control Contractor shall be responsible for a complete and operable control system, including equipment, installation, and accessories required to perform the functions specified on the drawings. The Control Contractor shall supervise the installation of all control equipment and accessories and shall submit shop drawings of the proposed system for approval.

2. The Control Contractor shall furnish and install all control conduit and wiring. All wiring shall be installed in EMT in accordance with the section Electrical. Provide plastic covered wires of not less than 18-gauge (16-gauge if longer than 50’), with at least one spare circuit at each control device. Control voltage shall not exceed 30 volts, except in starter pilot

circuits.

3. The Mechanical Contractor shall be responsible for installing all control valves, water flow switches, temperature wells, control dampers, and related equipment which is furnished by the Control Contractor.

4. The control system shall be basically electric, with supplementary electronic devices as required.

5. The Control Contractor shall be Climatech.

B. Control Equipment and Accessories:

1. Control Dampers:
   a. All control dampers are to be furnished under this section, except those specified to be furnished with the air handling units. Damper blades shall be fabricated of 22-gauge galvanized sheet steel and frames shall be not less than 16-gauge galvanized steel. Blades shall be maximum 10 inches wide, 50 inches long, and shall be provided with neoprene gasketed edges and oilite bronze or nylon bearings. Dampers shall be ultra-low leakage, opposed blade type for proportional action and parallel blade type for two-position action. Leakage performance shall be a maximum of 3 cfm per sq, ft. @ a pressure differential of 1" w.g. Provide damper operators for all motorized dampers and louvers. Belimo or approved equal. Submittals shall include leakage and pressure drop data for all control dampers. All outside air dampers shall fail closed.

2. Control Valves:
   a. Control valves 2-1/2" and smaller shall be screwed, 3" and larger shall be grooved or flanged. Screwed valves shall be bronze or cast brass, grooved valves shall be ductile iron, and flanged valves shall be cast iron or cast steel. Three way valves shall have contoured plugs for linear flow characteristics and constant total flow throughout the stem travel. Straight-thru valves shall be single seated and have equal percentage characteristics for water service. Flat discs shall be used for on-off control only. All valves shall be stainless steel stems, replaceable seats, and self-adjusting Teflon or rubber packing. All heating control valves shall fail open. Belimo or approved equal.

3. Air Duct Smoke Detector:
   a. Smoke detector shall be products of combustion detector and shall be UL listed. The unit shall be designed for detection of combustion gases, fire, and smoke in air ducts in compliance with NFPA Pamphlet 90A. The sheet metal contractor shall provide a minimum 18"x18" hinged access door, in inaccessible ceilings, for each detector that is furnished. The sheet metal contractor is also responsible for providing all necessary transitions in the ductwork for mounting of the duct detector.

4. Equipment Control Schematics:
   a. See Drawings for schematics and sequence of operations.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. General:

1. Install all materials and equipment as shown and in strict accordance with the applicable codes for the State and/or city. Plans do not attempt to show exact details of all piping and ductwork, and no extra payment will be allowed for offsets required due to obstructions by other trades. All work shall be done in a neat and orderly fashion and left in a condition satisfactory to the Architect/Engineer.

2. All piping shall be run parallel or perpendicular to established building lines. Install piping so as to allow for expansion. Install all valves with stems horizontal or above. Install air vents at all high points. Provide all piping which passes through walls, floors, or ceilings with standard weight pipe sleeves.

3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gasket shall be molded and produced by the grooved coupling manufacturer. Verify gasket grade is suitable for the intended service. The grooved coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools, application of groove, and installation of groove end products.

4. Install the grooved piping and fittings in accordance with the latest recommendations as published by the manufacturer. Pipe shall be square cut, +/-0.030", properly deburred and cleaned. Mark pipe ends at the required location using a gauge supplied by the Manufacturer to ensure full insertion into the coupling or fitting during assembly. Use a manufacturer's tool with proper sized jaw for pressing.

B. Insulation:

1. All piping insulation shall be applied over clean, dry surfaces after system has been pressure tested and any leaks corrected. Finished appearance of all insulation shall be smooth and continuous. Provide coat of insulating cement where needed to obtain this result.

2. Flexible duct insulation shall be secured to duct surface with 4-inch wide bands of adhesive applied on maximum 18-inch centers. Additional galvanized tie-wire support shall be furnished as required and recommended by the insulation manufacturer.

C. Diffusers, Registers and Grilles:

1. All diffusers, grilles, and registers shall be installed tight on their respective mounting surfaces and shall be accurately centered on ceiling tile, recesses, windows, or doors.

D. Ductwork:

1. All sheet metal work shall be done by qualified, experienced mechanics in accordance with the requirements of ASHRAE and the latest edition of the applicable SMACNA Manual. All

ductwork shall be installed in a neat and orderly manner, and shall be adequately supported to prevent vibration or sagging. All sheet metal ductwork shall be sealed with United-Sheet Metal Duct Sealer or equal.

E. Air Conditioning Units:

1. Units shall be installed approximately where shown on the plans to provide access space for filter changing, motor, drive and bearing servicing, and fan shaft and coil removing. Pipe drain pan connection through a running trap to floor drain. Unit shall not be operated until filters are installed. Isolate sheet metal ducts from all fans with flexible connectors.

F. Condensing Units/ Heat Pumps:

1. Units located at grade shall be positioned such that they are beyond the roof drip line. Units shall be installed on a 6" concrete pad.

2. Units located on flat rooftops shall be provided with Miro Industries Model HD, or equal, heavy duty galvanized roof support with adjustable legs, sized 6 inches larger, in each direction, than equipment footprint.

END OF SECTION 230100

SECTION 230150 - MECHANICAL START-UP

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The purpose of the mechanical start-up is to provide the owner of the facility with a high level of assurance that the mechanical system has been installed and operates per the requirements of the mechanical construction plans and specifications. The Mechanical General Provisions, Section 230000, is to be included as a part of this section of the specifications.

B. Pre-start and Start-up checklist:

1. The contractor shall be responsible for the completion of pre-start and start-up checklist forms. These forms can usually be obtained from the equipment manufacturer.

2. After completion of pre-start and start-up checklists, the contractor shall provide a copy of the pre-start and start-up checklist to the engineer for review and approval prior to substantial completion.

3. Approved Mechanical Equipment Start-up forms shall be included in the operations and maintenance manual.

PART 2 – START-UP PROCESS

2.1 RESPONSIBILITIES

A. Mechanical Contractor:

1. Coordinate with other trades involved in the installation of mechanical equipment to complete the requirements of mechanical start-up specifications.

2. Complete the pre-start and start-up checklist forms obtained from the equipment manufacturer.

3. Notify the mechanical engineer of tests to be witnessed. Contractor shall give the engineer a minimum of 48 hours notice prior to test.

B. Engineer:

1. Review the completed pre-start and start-up check lists provided by the mechanical contractor.

2. At final inspection, spot check items on the pre-start and start-up checklist forms to ensure that they have been completed.

2.2 EQUIPMENT PRE-START

A. Before starting any equipment or system, complete the system pre-start checklist forms. As part of the pre-start process, the following items shall be completed as applicable:

1. Piping systems shall be pressure tested as specified, found to be tight, with reports submitted.

2. Piping systems shall be flushed and cleaned as specified, all required reports submitted, and the system shall be filled or charged per plans.

3. Air system cleaning is complete and final filters shall be installed.

4. Vibration isolation and seismic restraints shall be installed per plans and specifications.

5. Equipment drives shall be aligned.

6. Electrical services shall be installed and checked.

7. Control points checkouts shall be completed.

8. Safety controls shall be installed and operation checked.

9. Manufacturer's representatives have carried out major equipment start-up, and all checks shall be documented on the relevant checklists as they are carried out.

10. Equipment has been thoroughly cleaned (interior and exterior of units), of construction debris.

11. Deficiencies or incomplete work shall be corrected and pre-start shall be repeated until the installation is ready for operation.

2.3 EQUIPMENT START-UP

A. After the pre-start up process described in Section 2.2, complete the system start-up checklist and document findings with forms provided. As part of the Start-up process, the following items shall be completed as applicable:

1. Air systems balanced as specified in plans and specifications.

2. Water systems balanced as specified in plans and specifications.

3. Problems revealed during balancing of air and water systems shall be corrected.

4. All automatic temperature controls devices shall be calibrated, including adjustments to control valves and damper actuators.

5. Set up or program controls for accurate response and precise sequencing to meet specified performance.

6. The controls contractor and balancing contractor shall adjust and set air flows and calibrate controls of equipment as applicable.

7. Ensure final adjustments to vibration isolation and seismic restraints are carried out per the manufacturer's requirements.

8. Check the operation of all fire dampers; smoke dampers and combination fire/smoke dampers.

B. Deficiencies or incomplete work shall be corrected, and the startup shall be repeated until correct installation and function has been confirmed and the installation is ready for engineer verification.

2.4 TRAINING AND INSTRUCTION

A. Once the substantial completion has been approved, the mechanical contractor shall provide the Owner and engineer with a training schedule for operation of the mechanical equipment and systems and their controls as listed in the specifications and plans. Reference Section 230000 Mechanical General Provisions, "Project Closeout" of these specifications.

PART 3 – EXECUTION

A. The following systems and equipment shall be completed under the mechanical start-up plan as described above and documented with equipment pre-start and start-up forms provided.

1. Packaged Rooftop Units

2. Ductless Split Systems

3. Electric Heaters

4. Hot Water Boilers

5. Pumps

6. Destratification Fans

7. Energy Recovery Units

8. Variable Frequency Drives

9. Miscellaneous Hydronic System Support Equipment

10. Water Source Heat Pumps

11. Exhaust Fans

12. Hoods

B. Pre-start and start-up forms are to be provided to the engineer for final approval before substantial completion.

C. Approved forms shall be included in the operations and maintenance manual.

END OF SECTION 230150

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.

2. Balancing Hydronic Piping Systems:
   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.

B. Additional Scope:

1. The Contractors shall work and assist the Commissioning Agent in the commissioning process.

1.2 DEFINITIONS

A. AABC: The Associated Air Balance Council, a nonprofit association of certified, independent test and balance agencies.

B. NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems

C. T&B: Testing, adjusting, and balancing

D. T&B Agency: An independent entity certified by AABC and/or NEBB to perform testing and balancing work

E. TBE: AABC and/or NEBB certified test and balance engineer

F. TBT: AABC and/or NEBB certified test and balance technician

G. HVAC: Heating, ventilating, and air conditioning

H. BAS: Building automation systems

1.3 SUBMITTALS

A. Qualifications: Within 30 days of Contractor's Notice to Proceed, submit qualifications of AABC and/or NEBB agency and personnel, including a sample copy of the National Performance Guaranty.

B. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit T&B strategies and step-by-step procedures as specified in Section 3.2, "Preparation."

C. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, Balancing Contractor shall provide system readiness checklists as specified in Section 3.2, “Preparation,” to be used and filled out by the installing contractors verifying that systems are ready for T&B.

D. Examination Report: Provide a summary report of the examination review required in Section 3.1, if issues are discovered that may preclude the proper testing and balancing of the systems.

E. Certified T&B report: Within 14 days of completion of balancing work, submit AABC or NEBB certified T&B report.

1.4 QUALITY ASSURANCE

A. Agency Qualifications: An independent T&B agency certified by AABC and/or NEBB

1. Supervisor: Employee of the T&B agency who is certified by AABC and/or NEBB as a TBE.

2. Technician: Employee of the T&B agency who is certified by AABC and/or NEBB as a TBT.

B. TBE shall perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified T&B reports.

2. Certify that the T&B team complied with the approved T&B plan and the procedures referenced in this Specification.

3. Certify the T&B report.

C. T&B Report Forms: Use approved forms submitted with the Strategies and Procedures Plan.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in the AABC National Standards for Total System Balance.

1.5 CONTRACTOR RESPONSIBILITIES

A. Provide T&B agency one complete set of contract documents, change orders, and approved submittals in digital and hard copy formats

B. Controls contractor shall provide required BAS hardware, software, personnel and assistance to T&B agency as required to balance the systems. Controls contractor shall also provide trending report to demonstrate that systems are complete.

C. Coordinate meetings and assistance from suppliers and contractors as required by T&B agency.

D. Provide additional valves, dampers, sheaves and belts as required by T&B agency.

E. Flag all manual volume dampers with fluorescent or other high-visibility tape.

F. Provide access to all dampers, valves, test ports, nameplates and other appurtenances as required by T&B agency.

G. Replace or repair insulation as required by T&B agency.

H. Have the HVAC systems at complete operational readiness for T&B to begin. As a minimum verify the following:

1. Airside:
   a. All ductwork is complete with all terminals installed.
   b. All volume, smoke and fire dampers are open and functional.
   c. Clean filters are installed.
   d. All fans are operating, free of vibration, and rotating in correct direction.
   e. VFD start-up is complete and all safeties are verified.
   f. System readiness checklists are completed and returned to T&B agency.

2. Hydronics:
   a. Piping is complete with all terminals installed.
   b. Water treatment is complete.
   c. Systems are flushed, filled and air purged.
   d. Strainers are pulled and cleaned.
   e. Control valves are functioning per the sequence of operation.
   f. All shutoff and balance valves have been verified to be 100% open.
   g. Pumps are started, and proper rotation is verified.
   h. Pump gauge connections are installed directly at the pump inlet and outlet flange or in discharge and suction pipe prior to any valves or strainers.
   i. VFD start-up is complete and all safeties have been verified.
   j. System readiness checklists are completed and returned to T&B agency.

I. Promptly correct deficiencies identified during T&B.

J. Maintain a construction schedule that allows the T&B agency to complete work prior to occupancy.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper T&B of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Note the locations of devices that are not accessible for testing and balancing.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas.

E. Examine equipment performance data including fan and pump curves.

F. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, clean permanent filters are installed, and controls are ready for operation.

G. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected, configured by the controls contractor and functioning.

H. Examine strainers to verify that mechanical contractor has replaced startup screens with permanent screens and that all strainers have been cleaned.

I. Examine two-way valves for proper installation and function.

J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine air vents to verify that mechanical contractor has removed all air from all hydronic systems.

3.2 PREPARATION

A. Prepare a T&B plan that includes:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Prepare system-readiness checklists, as described in the AABC or NEBB National Standards for Total System Balance, for use by contractors in verifying system readiness for T&B. These shall include, at a minimum:

1. Airside:
    a. All ductwork is complete with all terminals installed.
    b. All volume, smoke and fire dampers are open and functional.
    c. Clean filters are installed.
    d. All fans are operating, free of vibration, and rotating in correct direction.
    e. VFD start-up is complete and all safeties are verified.
    f. Automatic temperature-control systems are operational.
    g. Ceilings are installed.
    h. Windows and doors are installed.
    i. Suitable access to balancing devices and equipment is provided.

2. Hydronics:
    a. Piping is complete with all terminals installed.
    b. Water treatment is complete.
    c. Systems are flushed, filled and air purged.
    d. Strainers are pulled and cleaned.
    e. Control valves are functioning per the sequence of operation.
    f. All shutoff and balance valves have been verified to be 100% open.
    g. Pumps are started and proper rotation is verified.
    h. Pump gauge connections are installed directly at the pump inlet and outlet flange or in discharge and suction pipe prior to any valves or strainers.
    i. VFD start-up is complete and all safeties are verified.
    j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing on each system according to the procedures contained in the latest version of the AABC or NEBB National Standards for Total System Balance and in this Section.

B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain approved submittals and any manufacturer-recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare a single-line schematic diagram of systems for the purpose of identifying HVAC components.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check condensate drains for proper connections and functioning.

H. Check for proper sealing of air-handling-unit components.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow as follows:
    a. Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:
    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows.

1. Measure airflow of sub-main and branch ducts.

2. Adjust sub-main and branch duct volume dampers for specified airflow.

3. Re-measure each sub-main and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.

2. Measure airflow at all inlets and outlets.

3. Adjust each inlet and outlet for specified airflow.

4. Re-measure each inlet and outlet after all have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.

2. Re-measure and confirm total airflow is within design.

3. Re-measure all final fan operating data, rpms, volts, amps, static profile.

4. Mark all final settings.

5. Test system in economizer mode. Verify proper operation and adjust, if necessary. Measure and record all operating data.

6. Record final fan-performance data.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils and heat exchangers. Obtain approved submittals and any manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger gpms with pump design flow rate.

B. Verify that hydronic systems are ready for testing and balancing:

1. Check liquid level in expansion tank.

2. Check that makeup water has adequate pressure to highest vent.

3. Check that control valves are in their proper positions.

4. Check that air has been purged from the system.

5. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

6. Verify that motor starters are equipped with properly sized thermal protection.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.

1. Measure total water flow.
   a. Position valves for full flow through coils.
   b. Measure flow by main flow meter, if installed.
   c. If main flow meter is not installed determine flow by pump total dynamic head (TDH) or exchanger pressure drop.

2. Measure pump TDH as follows:
   a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
   b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
   c. Convert pressure to head and correct for differences in gauge heights.

d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
e. With all valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.

2. Adjust main and branch balance valves for design flow.

3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow measuring devices installed at terminals for each space to design water flows.

1. Measure flow at all terminals.

2. Adjust each terminal to design flow.

3. Re-measure each terminal after all have been adjusted.

4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.

5. Perform temperature tests after all flows have been balanced.

D. For systems with pressure-independent valves at the terminals:

1. Measure differential pressure and verify that it is within manufacturer’s specified range.

2. Perform temperature tests after all flows have been verified.

E. For systems without pressure-independent valves or flow measuring devices at the terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.

2. If balanced by coil pressure drop, perform temperature tests after all flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.

2. Re-measure all final pump operating data, TDH, volts, amps, static profile.

3. Mark all final settings.

G. Verify that all memory stops have been set.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential pressure (DP) sensor is located per the contract documents.

2. Determine if there is diversity in the system.

B. For systems with no diversity:

1. Follow procedures outlined in section 3.8 for constant-flow hydronic systems.

2. Prior to verifying final system conditions, determine the system DP setpoint.

3. If the pump discharge valve was used to set total system flow with VFD at 60 Hz, at completion open discharge valve 100% and allow VFD to control system DP setpoint. Record pump data under both conditions.

4. Mark all final settings and verify that all memory stops have been set.

C. For systems with diversity:

1. Determine diversity factor.

2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.

3. Follow procedures outlined in section 3.8 for constant flow hydronic systems.

4. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance the terminals that were just opened.

5. Prior to verifying final system conditions, determine the system DP setpoint.

6. If the pump discharge valve was used to set total system flow with VFD at 60 Hz, at completion open discharge valve 100% and allow VFD to control system DP setpoint. Record pump data under both conditions.

7. Mark all final settings and verify that all memory stops have been set.

3.9 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus or minus 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Minimum Outside Air: Zero to plus 10 percent.

4. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

5. Hydronic-Water Flow Rate: Plus or minus 10 percent.

3.10 FINAL TEST & BALANCE REPORT

A. The report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the T&B process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel. All measurements and test results that appear in the reports must be made on site and dated by the AABC or NEBB technicians or test and balance engineers.

B. The report must be organized by systems and shall include the following information as a minimum:

1. Title Page:

- AABC/NEBB Certified Company Name
- Company Address
- Company Telephone Number
- Project Identification Number
- Location
- Project Architect
- Project Engineer
- Project Contractor
- Project Number
- Date of Report
- AABC Certification Statement
- Name, Signature, and Certification Number of AABC/NEBB TBE

2. Table of Contents.

3. AABC/NEBB National Performance Guaranty.

4. Report Summary:

- The summary shall include a list of items that do not meet design tolerances, with information that may be considered in resolving deficiencies.

5. Instrument List:

- Type
- Manufacturer
- Model

- Serial Number
- Calibration Date

6. T&B Data:

   - Provide test data for specific systems and equipment as required by the most recent edition of the AABC or NEBB National Standards.

C. One copy of the final test and balance report shall be sent directly to the engineer of record. Provide five (5) additional copies to the contractor.

END OF SECTION 230593

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SECTION 230800 – HVAC COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. This Section includes requirements for commissioning the HVAC system and its subsystems and equipment, including the Direct Digital Control system.

B. The registered design professional is responsible to provide evidence of mechanical systems commissioning and completion in accordance to the provisions of this section.

1.3 DEFINITIONS:

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. RDP: Registered Design Professional

C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

D. TAB: Testing, Adjusting, and Balancing.

1.4 COMMISSIONING DOCUMENTATION:

A. Commissioning Plan: A commissioning plan will be developed by a registered design professional or approved agency and shall include the following items:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.

2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.

3. Functions to be tested, including, but not limited to calibrations and economizer controls.

4. Conditions under which the test will be performed. At a minimum, testing shall affirm winter and summer design conditions and full outside air conditions.

5. Measurable criteria for performance

B. Test Checklists: RDP, with assistance of Architect/Engineer, shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist.

1. Name and identification of tested item.

2. Test number.

3. Time and date of test.

4. Indication of whether the record is for a first test or retest following correction of a problem or issue.

5. Date of the test and name of parties involves as applicable.

6. Individuals present for test.

7. Deficiencies/Issues/Results of test.

8. Note if re-test is necessary.

C. Test and Inspection Reports: RDP shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. RDP shall compile test and inspection reports and tests and inspection certificates and include them in systems manual and commissioning report.

D. Corrective Action Documents: RDP shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

E. Issues Log: RDP shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.

1. Creating an Issues Log Entry:
    a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
    b. Assign a descriptive title of the issue.
    c. Identify date and time of the issue.
    d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
    e. Identify system, subsystem, and equipment to which the issue applies.
    f. Identify location of system, subsystem, and equipment.
    g. Include information that may be helpful in diagnosing or evaluating the issue.
    h. Note recommended corrective action.
    i. Identify commissioning team member responsible for corrective action.
    j. Identify expected date of correction.
    k. Identify person documenting the issue.

2. Documenting Issue Resolution:
    a. Log date correction is completed or the issue is resolved.
    b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
    c. Identify changes to the Contract Documents that may require action.
    d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
    e. Identify person(s) who corrected or resolved the issue.
    f. Identify person(s) documenting the issue resolution.

3. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, RDP shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, RDP shall include the following information in the issues log and expand it in the narrative:
    a. Issue number and title.
    b. Date of the identification of the issue.
    c. Name of the commissioning team member assigned responsibility for resolution.
    d. Expected date of correction.

F. Commissioning Report: RDP shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report shall include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances in the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.

2. Commissioning plan.

3. System balance reports.

4. Testing plans and reports.

5. Corrective modification documentation.

6. Issues log.

7. Completed test checklists.

8. Listing of off-season tests not performed and a schedule for their completion.

G. Systems Manual: RDP shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:

1. Submittal Data stating equipment size and selected options for each piece of equipment requiring maintenance.

2. Operation and maintenance data on each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.

3. Name and address of at least one service agency.

4. HVAC controls system maintenance and calibration information.

5. A narrative of how each system is intended to operate, including recommended setpoints.

PART 2 – PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 BALANCING:

A. Scope:

1. Prior to final acceptance by the Owners, all air systems shall be balanced to deliver the quantities as specified or directed. The air balance shall be performed by an independent agency specializing in balancing and is certified by the National Environmental Balancing Bureau.

2. The Mechanical Contractor shall provide assistance to the Balancing Contractor by identifying all installed mechanical systems and assisting access to all installed mechanical systems. All mechanical systems shall be completely operational and functional prior to the Balancing Contractor performing his specified work.

B. Air balancing:

1. Balancing of the air system shall consist of:

a. Adjust all air volumes to the quantities shown, with allowable variation of plus 10, minus 10 percent.

b. Record all system, zone, diffuser, grille, and register C.F.M. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Balancing Engineer shall work with the Contractor to set minimum & maximum CFM quantities for zone dampers, or zone dampers/heaters.

c. Test and record all system static pressures, inlet and discharge, on all packaged units, fans, and terminal units. Vary total system air quantities by adjustment of fan speeds. Provide drive changes as necessary. Vary branch air quantities by damper regulation.

d. Test and record motor full load amps and nameplate amps.

e. Test and record entering and leaving temperatures at all coils.

f. Adjust all automatically operated dampers, in cooperation with the Control Contractor,

to the required settings. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions within specified tolerances. Where modulating dampers or economizers are provided, take measurements at full return air, minimum outside air, and 100 percent outside air mode of operation.

g. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and excessive noise where possible.

h. Mark final positions of all balance dampers with a red felt pen.

i. Air systems shall be balanced in accordance with standard procedures and recognized practices of the Associated Air Balance Council, and the Testing Adjusting, and Balancing Bureau.

C. Quality Assurance:

1. The Balancing Contractor shall demonstrate to the Engineer of record, flow verification for at least 10% of the balanced devices as selected by the Engineer. If more than 25% of the tested devices do not meet the designed or balance report, then the entire system balance must be rebalanced.

D. Balance Reports:

1. Submit four copies of the air system balance report to the Architect/Engineer for evaluation and approval. Reports shall be on TABB/SMACNA forms that indicate information addressing each of the testing methods, readings, and adjustments.

3.2 TESTING:

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from RDP. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions

2. Alter set points when simulating conditions is not practical and when written approval is received from RDP.

3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

C. Scope of HVAC Subcontractor Testing.

1. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall

include measuring capacities and effectiveness of operational and control functions.

2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. Detailed Testing Procedures: RDP, with HVAC Subcontractor, TAB Subcontractor, and HVAC Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.

E. HVAC Instrumentation and Control System Testing.

1. The CxA, HVAC Subcontractor, and the HVAC Instrumentation and Control Subcontractor shall collaborate to prepare testing plans.

2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.

F. Energy Supply System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of refrigerant systems and equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each equipment item and pipe section to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in system testing plan.

2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

G. Heat-Generation System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of auxiliary heating equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of heat strip to be tested, identified by identification marker. Markers shall be keyed to Drawings for each heating sector showing the physical location of each item of equipment and test section. Drawings shall be formatted to allow each item of equipment and section of heat strip to be physically located and identified when referred to in the system testing plan.

2. Tracking checklist for managing and ensuring that all heating sections have been tested.

H. Refrigeration System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of all condensing units, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

I. HVAC Distribution System Testing: HVAC Subcontractor shall prepare a testing plan to verify performance of air, and refrigerant distribution systems; special exhaust; and other distribution systems. Include HVAC terminal equipment and unitary equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

J. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.

2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

J. Mechanical and Controls Contractor Work Scope:

1. The contractors shall provide complete system demonstrations on all modes of operations to the Engineer. Trending data may be required to confirm proper operations of select systems.

END OF SECTION 230800

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SECTION 230900 – DIRECT DIGITAL CONTROL SYSTEM

Part 1 SYSTEM OVERVIEW

A DDC CONTROL SYSTEM

1 Statement of Intent

The intent of this specification is to provide a high-quality Direct Digital Control system with Web based software front end and top-of-the-line control hardware. System is to include a Graphical User Interface (GUI) residing on a Webserver accessible with an industry standard non-proprietary Web Browser. Connectivity shall be over the owner's internal Ethernet system and, when allowed, over the Internet using the servers IP address. Connection to the Webserver software shall be thin client access and shall not require that the browser device have special software or applets for access. If connection to an Intranet or to the Internet is not available on initial installation, the server shall be accessed via a web browser locally hosted on the server. The graphic user interface shall display real time values of all system operating conditions. Additionally, it shall include graphic displays of system programming, operating logic and logic flow. It shall display logic flow with real time values of logical inputs and outputs. This graphical display capability is required for system diagnostics of both the mechanical systems controlled by the DDC system and of the operating logic and sequences themselves. The features of the system must be fully installed, configured and demonstrated in a manner that provides maximum benefit to the end user.

2 Specification Compliance

These specifications are intended to provide minimum capability for the DDC system. Manufacturer's data sheets included in the submittals will be reviewed to verify significant hardware and software system features. Key system features must be documented by manufacturer's data sheets in the submittals or by demonstration of an existing installation.

3 Approved DDC Contractor and System

DDC Control System shall be:

Automated Logic WebCTRL by Clima-Tech Corporation

4 System shall Fully integrate into the existing Jerome SD campus DDC system.

B SCOPE OF WORK

Refer to the matrix at the end of this specification that shows the scope of responsibility for the various trades:

1 Control Hardware and Software

The Automatic Temperature Control (ATC) Contractor shall be responsible for furnishing and installing all control hardware and software necessary for a complete DDC control system as specified. ATC contractor shall furnish all modules, temperature sensors, flow sensors, humidity sensors, IAQ sensors, control valves, control valve actuators, dampers, damper actuators and any other items necessary for a complete system and sequence of control, except those valves, dampers and actuators specified to be furnished by equipment supplier. When actuators are specified to be furnished by equipment supplier, that supplier shall be responsible for coordination of actuator

control input for interface with DDC system without use of transducers. Automatic control valves, dry wells for fluid temperature sensors, dampers and actuators shall be installed by the mechanical contractor.

Specifically, the ATC Contractor shall furnish the following:

a Individual unitary control modules for each unitary system:

- *Water Source Heat Pumps*
- *Rooftop Units*
- *Electric Heaters*
- *Ductless Split Systems*

b Individual control modules for all non-unitary air handlers or package units:

- *Energy Recovery Unit*
- *Exhaust Fans*
- *Destratification Fans*
- *Domestic Hot Water Pump Control*

c General purpose modules for control of central fan, pump, chiller, boiler, or tower operation:

- *Central Plant*

d Required peripheral mechanical components to be furnished by ATC contractor:

- *Zone damper actuators*
- *Economizer damper actuators not specified as part of mechanical equipment*
- *Control dampers not specified as part of mechanical equipment*
- *Control valves and actuators*

e Required non-HVAC controls to be furnished by ATC contractor:

- *Refrigerator / Freezer Monitor*
- *Lighting Control Panel (Provided by ATC contractor and installed by EC)*

f Required software integration to other digital control systems:

None

2 Control Wiring and Interface to Line Voltage Control

ATC Contractor shall be responsible for control wiring to all control modules, sensors, pilot duty control relays and actuators required to provide Sequences of Operation as noted in Part 5. ATC contractor shall provide control interface to boilers, chillers, pumps and fans. This shall include pilot duty relays where interface to line voltage switching devices is required. ATC Contractor shall provide all required conduit for low voltage wiring within mechanical rooms or at equipment locations unless specifically shown on Division 16 drawings. Electrical Contractor shall provide all required conduit for line voltage wiring, all contactors, magnetic starters and motor control centers required for operation of mechanical systems except where specifically noted to be provided by equipment manufacturer. Electrical contractor shall furnish conduit where required between the zone temperature sensor locations and the zone equipment. The Electrical Contractor shall also be responsible for line voltage circuits and connection to ATC panels.

Unitary equipment will be supplied with required fan relays, compressor contactors, electric heat sequencers and transformer ready for connection to ATC provided control modules.

3 Control Integration with Third Party Digital Controls Supplied by Others

Automatic Temperature Control (ATC) Contractor shall be responsible for all programming of controls furnished by them to accomplish the required integration. ATC Contractor shall provide necessary hardware to maintain these programs. Local area network wiring required for connection to interface hardware provided under the ATC project scope is the responsibility of the ATC Contractor. If Ethernet connection to third party controls is required, that network connection shall be the responsibility of others.

Suppliers of equipment that is required to be integrated with the DDC system shall be responsible to coordinate integration software protocol and connectivity with ATC Contractor prior to bid to insure satisfactory integration and system operation. Equipment suppliers are required to confirm that their factory installed controls are capable of achieving sequences of operation listed under this section, and that required points are available to the DDC system. If specified sequences cannot be met with factory installed controls the equipment supplier shall be responsible for furnishing and installing required external controls or peripheral devices. Any required communication wiring between digital control devices provided by equipment suppliers shall be the responsibility of that supplier. This may be under separate agreement with the ATC Contractor.

Equipment suppliers shall provide complete points list including Usage Description, Addresses and Device ID numbers, and network number if applicable.

Acceptable protocols:

Variable Frequency Drives, lighting systems or power monitoring systems shall use either Modbus or BACnet software protocols for integration to this DDC system.

All other systems shall use BACnet software protocol for integration to this DDC system.

4 Commissioning

ATC Contractor shall be responsible for self-commissioning of all hardware and software programming furnished with the project. Completed point checkout commissioning sheets shall be included with the final “as-built” O&M manuals. These sheets shall include validation check fields for each physical and software or network input and output, with date and time of verification and initials of individual preforming the checkout. Physical point checkout lists shall include check offs for point type, address, scaling range, and any calibration offset. Software point checkout lists shall include check offs for mapped address and communication verification. Point checkout lists shall use logical names for future reference by the owner.

Each graphic file will be checked for visual accuracy and to verify that point mapping on those files is correct. Each unique operating program shall be functionally tested to confirm that operation conforms to the Sequence of Operation. Documentation of graphic commissioning and Functional Performance Testing shall be included in the project O&M manuals.

5 SUBMITTALS AND O&M MANUALS

a Submittals

Submittals shall include the following sections:

i Shop Drawings with:

- Title Page
- Table of Contents
- Typical Device Wiring Drawings
- Summary Bill of Materials
- Sequences of Operation
- Local Area Network Drawings
- Drawings for all operating systems showing both equipment and module connections
- Bill of Materials Specific to Each Drawing

ii Manufacturer's specification data sheets for all:

- control modules
- sensors
- dampers
- valves
- actuators
- flow switches
- current sensors
- transducers

If the contractor wishes to substitute any item after approval of submittal they shall submit appropriate data sheets for approval before including substituted product on the project.

b O&M Manuals

O&M Manuals shall be furnished upon project completion and include technical instructions for all items originally included in the submittal with "as built" modifications and completed Commissioning Worksheets. O&M Manuals shall be in a separate three ring binder. Contractor's toll free technical support number or the words "Call Collect" with the contractor's regular phone number shall be on the front of the manual.

6 SYSTEM SOFTWARE

System Software shall include the following:

DDC operating system

Any software required for control logic programming

Any software required for graphics generation

Any other software used to create a fully functional system

Site specific database

All software programs shall be installed on the owner's server.

All licenses shall become the property of the Owner

Part 2 CONTRACTOR CAPABILITY

1 Contractor shall maintain toll-free technical support phone line or accept collect phone calls during warranty period.

2 Contractor shall provide service within 24 hours.

3 Contractor service and installation technicians shall be technically proficient in both control systems and mechanical service.

Part 3 HARDWARE

A SYSTEM SERVER

Software shall be installed and viewed on existing Automated Logic Corporation WebCTRL software and server.

B FIELD HARDWARE

1 BACnet

The system shall be fully native BACnet at the time of installation. The system shall use BACnet as the native communication protocol between distributed controllers communicating on the controller network (i.e. Field Bus) and must, as a minimum, support the following Objects and Application Services (Conformance Class 3):

Objects >	Binary Input	Services >	Readproperty
	Binary Output		Writeproperty
	Binary Value		I-Am
	Analog Input		I-Have
	Analog Output		ReadMultiple Property
	Analog Value		WriteMultiple Property
	Calendar		Who-Has
	Schedules		Who-Is

2 Distributed Control

System shall observe the concept of distributed control. All modules shall have “stand alone” capability and shall maintain operator set points without connection to primary controllers or central station equipment. Modules shall be located at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network. Equipment operating logic, schedules and current trends shall reside in control modules serving each system. Use of global modules required to maintain programming, schedules or current trend data are not acceptable.

3 Ethernet Gateway Routers

System shall include an Ethernet Router/Gateway between the control module network and owners Ethernet. This gateway shall route BACnet communications between the control module network and the owners IP network. If the system is not to be connected to the customer's Ethernet the gateway shall be capable of connection via a web browser on the local host server.

4 Control Modules

a Control modules shall include required inputs and outputs to meet sequence of operation and points list. Digital outputs shall be dry contact relays and analog outputs shall be industry standard 0-10 vdc, 2-10 vdc or 4-20 milli-amp. Triac digital outputs are not acceptable.

b Modules shall be fully programmable for maximum system flexibility. Application specific controllers are not acceptable.

c All modules shall have battery backup capable of maintaining all programs, set points, schedules and trend information for a minimum of 7 days.

d All schedules and current trends shall be maintained in the individual control modules. The modules shall be capable of maintaining sufficient trend samples to report 24 hours of trend history in 5-minute increments for each input or output.

e Control Modules shall communicate via BACnet over either:

i ARCnet at a speed of 156k baud

ii MS/TP at a speed of 76.8k baud

iii ARCnet systems shall also be capable of supporting slower MS/TP communications buss when required for interface to other BACnet devices.

5 Temperature Sensors (analog)

a Wall mounted zone temperature sensors shall be 10 k ohm thermistor.

i Zone sensors in primary occupied areas <u>other than</u> restrooms, hallways or storage rooms shall have set point adjustment to allow the occupants to raise or lower the set point within operator defined parameters. Additionally, sensors in these primary areas shall have a push button to return the system to normal occupancy set points for an operator defined period. Exception will be common areas.

ii Zone sensors for restrooms, hallways, storage rooms, gymnasiums, auditoriums and locker rooms shall be mounted on the back of an aluminum electrical box cover plate designed for zone sensing application.

iii Gymnasium sensors shall also include a key access override feature.

b All other temperature sensors shall be industry standard thermistor or 4-20 milli-amp.

c Minimum of two outside air sensors are required for each facility and software programmed to use the lower temperature of the two for any control logic that uses OAT.

d Immersion sensors shall be mounted in a blind well for future serviceability.

6 AHU Freeze Protection Thermostats (binary)

a All Air Handling Units with outside air and Heating Water, Chilled Water, Condenser Water or Steam coils shall have a manual reset binary freeze protection thermostat installed downstream of each coil. Exceptions shall be made when water circuits are protected with glycol.

b Freeze protection thermostats shall be wired to directly open the control circuits for the fans. Control module outputs for freeze protection shall only be used for redundancy.

c An auxiliary switch on the freeze protection shall be wired to the AHU control module for alarming and additional control actions.

7 Current Transformers

a Current transformers used for fan status on belt drive constant volume air handlers shall be adjustable type. These shall be calibrated to indicate fan failure on belt loss.

b Current transformers used for pump status on pumps larger than 1 horsepower shall be adjustable type. These shall be calibrated to indicate pump failure when the pump cavitates on flow loss.

c Current transformers used for fan status on variable frequency drives shall be analog type. Software should note max flow amperage. Equipment program will indicate fan loss if amp draw drops below 60% of max flow amperage and software requests drive speed above 50 hz.

8 Pressure Sensors (analog)

a Duct pressure sensors used for control of variable air flow air handling units shall be located in the longest duct run approximately 2/3 of the total duct length from the AHU.

b Building pressure sensors used for control of outside or relief air shall have more than one OA pressure reference point to minimize wind effects. OA pressure pickup shall be protected against blockage by insects.

c Hydronic pressure sensors used for control of variable flow pumps shall be located across a unit without a two way valve and pressure differential set 1.5 times the design pressure drop across that unit.

9 Hi Pressure Safety (binary)

a Variable air flow air handling units shall have a manual high static pressure safety located at the AHU outlet to provide safety shut down if pressure exceeds 5” for more than 30 seconds. Variable frequency drives should be programmed for soft start to prevent nuisance tripping on startup.

10 Valve and Damper Actuators

a Actuators shall be manufactured by Belimo.

b Torque shall be rated 20% above required load.

c Modulated actuator input shall be industry standard 0-10 vdc, 2-10 vdc, 4-20 milli-amp, floating motor (tri-state), or pulse width modulation. Two or three position operation is not acceptable for economizers, VAV dampers, multi-zone dampers, valves or any other application where modulated operation is specified.

d Damper actuators used on any damper where one side is exposed to outside air shall have spring return to close dampers upon loss of power.

e Valve actuators used on any Heating Water Valve shall have spring return to open valve upon loss of power.

f Valve actuators used on any Steam Valve shall have spring return to close valve on loss of power.

11 Dampers

a Any damper where one side is exposed to outside air shall have neoprene or vinyl-grip blade seals, stainless spring steel edge seals and a specified leakage rate of not more than 65 CFM/damper face area at 2" W.G. static pressure drop. Exception will be combustion intake dampers and air to air heat exchange relief dampers.

b When outside air intake dampers for economizers are furnished by ATC Contractor those dampers shall be opposed blade style.

c Individual damper blades shall not exceed 48".

12 Wire

a All wiring in open areas at heights below 12 feet must be run in conduit.

b Control wiring may be run open in accessible ceiling or under floor areas.

c Control wiring in non-accessible ceilings, walls or floors shall be in conduit.

d All wiring not in conduit or control cabinets shall be rated for plenum installation.

e Communication wiring shall be run in data cable tray whenever possible.

Part 4 SOFTWARE

A MULTIPLE OPERATING PLATFORMS

The front-end server software furnished as a part of the DDC system shall be capable of operating on multiple operating systems such as Microsoft Windows, Linux or Sun Solaris.

B MULTI-BROWSER ACCESS

Internet, Intranet or Local Host access to the system shall be via thin client browser access using any standard browser, such as Internet Explorer, Firefox or Chrome

C GRAPHICAL PROGRAMMING

The system shall be programmed using a graphical programming language for ease of operator

understanding. Operating sequences and logic flow shall be assembled in a schematic format using visually descriptive micro-blocks or icons representing inputs, outputs and logical functions such as and/or logic, set points, switches, limits, relays, PIDs etc. The programming software shall be furnished within this scope of work.

Full simulation capability shall also be provided with the graphic programming. User shall be able to fully simulate the constructed sequence on screen before the sequences are downloaded into the controllers. The system shall also include the ability to simulate multiple graphic programs communicating with each other on a simulated network.

D GRAPHICAL INTERFACE SOFTWARE

1 System and Equipment Graphics

The operator's interface software shall be graphics based and display in 256 colors at a minimum 1024 x 768 pixel resolution. Graphics display screens shall include a system level graphic of either a map of facilities or an elevation of the building, a graphic of each building floor plan and graphics for each operating system or unit within each building. Entry to the zone and equipment level interface graphics shall be through area maps and/or floor plans to facilitate user orientation. Additionally, the system hierarchy shall be displayed in a fashion similar to Windows Explorer to enable the user to navigate to any graphical screen in the system by expanding building levels or floor levels and selecting a particular zone or system. Graphics shall be accessed by using a mouse or other pointer device. The system shall provide a visual indication of which building, floor and zone the user is accessing at any time. System shall be capable of changing all parameters and schedules, as well as downloading operating software from the same Graphical User Interface software program as that used for viewing system operation.

Thermal graphic floor plans shall display each temperature zone in a color appropriate to current space temperature conditions. The system shall display in 8 separate colors the following conditions: High or low temperature alarm, temperature at set point, cooling call, heating call, more than 2° above set point, more than 2° below set point, unoccupied between set points and no communication. Floor plans shall also include color graphic indicators for non-zone specific mechanical equipment operation showing On/Off and Alarm Conditions. Status indication colors shall be updated dynamically as conditions change.

Mechanical equipment pictorial graphics shall be displayed by the use of point-and-shoot selection using a mouse or other pointer device. Graphics shall be provided for all mechanical equipment and devices controlled by the DDC system. These graphics shall provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.

2 Graphical Screen Replay

The system shall have the ability to replay up to 24 hours of thermal graphic floor plans, equipment graphics, alarms or trend pages, starting at a specified date and time as a troubleshooting tool.

3 Software Graphic Programming Live User Interface

The system shall be able to display the graphic displays of system programming, operating logic and logic flow with real time conditions displayed at each input, output and logical function. This display will allow the operator to observe each step of a control logic process and facilitate system software troubleshooting. Operator shall have the ability to select any mirco-block in the graphical program to change parameters including the ability to lock values.

E FACILITY MANAGEMENT AND ENERGY MANAGEMENT FUNCTIONS

1 Scheduling

a For maximum flexibility, schedules shall reside in the local control modules. Systems that rely on Central Control Modules for scheduling are not acceptable.

b Schedules shall be at the zone level. Central plant or fan operations shall not be scheduled, rather they shall run based on requests from the zones that they serve.

c The DDC system shall have the ability to schedule each individual zone, each building or floor or the entire network of buildings for any user with a single entry. Additionally, the operator shall have the capability of assembling groups of zones, buildings or floors for single entry programming, e.g. several offices may be grouped for scheduling of Saturday operations.

d Available schedule types shall include normal operation, unoccupied operation, setback override and holidays.

e Dated schedules shall be self-managing and automatically delete after execution.

2 Demand Control

The system shall have the ability to receive an analog or digital input of electrical usage/demand through any open input on a general-purpose module. If demand control is implemented in the future, this capability shall not require any additional DDC hardware except the single input point and, when implemented, the digital or analog devices required to read electrical demand levels.

The system shall be capable of rotating greater or lower demand levels every 10 minutes to alternate zones throughout the facility to minimize long term set point offset.

3 Interactive Operations

The system shall have the ability to send run requests, heating requests and cooling requests from one module to another for the purpose of optimizing run operations of central plant equipment. Additionally, the system shall be capable of limiting operation of various equipment if another mechanical point elsewhere in the system allows that operation. e.g. a boiler loop circulating pump shall run only when requested by a zone requiring heating operation and will shut down during hours that zone demand is satisfied.

4 Enterprise Integration

The system shall be capable of exchanging web services (via XML/SOAP) information with other Enterprise servers for the purpose of optimizing system operation, e.g. obtaining NOAA Weather Service for optimizing night purge operation, or for the purpose of providing information to other Enterprise servers to optimize other building information systems, e.g. providing maintenance notifications to an Enterprise based facilities maintenance software.

5 Energy Reporting Tools

System shall include an easily configured energy reporting tool that provides the capabilities described in this section. This reporting software shall be resident on the customer server and shall not have any additional subscription support cost.

a The energy reporting tool shall:

i be accessible through the same user interface (Web browser or operator workstation software) that is used to manage the BAS.

ii be preconfigured by the Contractor to gather and store energy demand and consumption data from each energy source that provides metered data to the BAS. Meter data shall be stored at 5-minute intervals unless otherwise specified in the Sequence of Operation below. This data shall be maintained in an industry standard SQL database for a period of not less than five years.

iii allow the operator to select an energy source and a time period of interest (day, week, month, year, or date range) and shall provide options to view the data in a table, line graph, bar graph, or pie chart.

iv allow the operator to select two or more data sources and display a comparison of the energy used over this period in any of the listed graph formats, or to total the energy used by the selected sources and display that data in the supported formats.

v allow the operator to select an energy source and two time periods of interest (day, week, month, year, or date range) and display a graph that compares the energy use over the two time periods in any of the graph formats listed in the previous paragraph.

vi allow the operator to select multiple energy sources and display a graph that compares the total energy used by these sources over the two time periods.

vii allow the operator to easily generate the previously described graphs "on the fly," and shall provide an option to store the report format so the operator can select that format to regenerate the graph at a future date.

viii allow the user to schedule these reports to run on a recurring basis using relative time periods, such as automatically generating a consumption report on the first Monday of each month showing consumption over the previous month.

b System shall be capable of automatically generating reports that can be archived on the server in a common industry format such as Adobe PDF or Microsoft Excel. System shall be capable of e-mailing reports to a user editable list of recipients.

c The energy reporting tool shall be capable of collecting and displaying data from the following types of meters:

i Electricity

ii Gas

iii Oil

iv Steam

v Chilled Water

vi Potable Water

vii Heating and cooling degree days. (May be calculated from sensor data rather than metered.)

d The system shall be capable of using kW (kWh) or Btu/hr (Btu), or multiples of these units, e.g. MWH, kBtu, as the units for demand and consumption reports. All selected sources shall be automatically converted to the selected units. The user shall similarly have the option of entering facility area and occupancy hours and creating reports that are normalized on an area basis, an annual use basis, or an occupied hour basis.

e Capability shall include the option of entering benchmark data for an individual facility or a group of facilities.

f Capability shall include the option of displaying any or all of the following data on any chart, line, or bar graph generated by the energy reporting tool:

i Low/High/Average value of the metered value being displayed.

ii Heating and/or Cooling Degree Days for the time period(s) being displayed.

iii The Environmental Index for the facilities and time periods being displayed.

6 Environmental Index.

System shall monitor all occupied zones and compile an index that provides a numerical indication of the environmental comfort within the zone. As a minimum, this indication shall be based upon the deviation of the zone temperature from the heating or cooling set point. If humidity is being measured within the zone then the environmental index shall be adjusted to reflect a lower comfort level for high or low humidity levels. Similarly, if carbon dioxide levels are being measured as an indication of ventilation effectiveness, then the environmental index shall be adjusted to indicate degraded comfort at high carbon dioxide levels. Other adjustments may be made to the environmental index based upon additional measurements. The system shall maintain a trend of the environmental index for each zone in the trend log. The system shall also compute an average comfort index for every building included in this contract and maintain trend logs of these building environmental indices. Similarly, the system shall compute the percentage of occupied time that comfortable conditions were maintained within the zones. Through the UI the user shall be able to add a weighting factor to adjust the contribution of each zone to the average index based upon the floor area of the zone, importance of the zone, or other static criteria.

7 ALARMS, TRENDS AND REPORTS

a System and Temperature Alarms

The system shall have the capability of monitoring conditions throughout the system and sending alarms via text or messages to an e-mail address, local PC or printer or to remote PC's, printers or to dial-up pagers. Alarms and messages shall be able to be prioritized for various levels of reporting and action. The operator shall have the ability to customize alarm text and messages.

b Trends

The system shall be capable of trending any input or output, or any logical point within an operating program, e.g. output of a PID. There shall be no limitation to the number of points that can be trended at any particular time. Modules shall store in live memory 288 trend samples

points for each trended item. The interval between trend samples shall be adjustable from 1 second to 24 hours. Trends from one or more modules shall be able to be simultaneously displayed on a single trend graph. Operator shall be able to "window" any segment of a trend to enlarge the view by dragging a mouse to form the "window". The system shall also have the ability of automatically downloading trend information from any module to the server or other computer connected to the network for historical trend storage. This trend information shall be able to be displayed on the trend graph along with live current trends in seamless fashion. Trend data collection requiring the use of a locally connected PC for data storage is unacceptable.

c Reports

The system shall be capable of generating reports of equipment run times, all trended points, temperature conditions, electric demand and usage, and alarms or messages. The system shall also have the ability of automatically downloading report information from any module to the server or other computer connected to the network. The operator shall have the ability to create custom report and logging formats.

Part 5 SEQUENCES OF OPERATION

A GENERAL

The following sequences of operation shall be strictly observed. All temperature set points, static pressure set points, percentage of PID output trip points and reset ratios within this specification shall be changeable by operator using the operator software furnished with the system.

B DISTRIBUTED CONTROL

System shall observe the concept of distributed control. Modules shall be located at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network.

C CENTRAL PLANT, PUMP AND FAN OPERATION

Control of all central fan systems, chillers, boilers and pumping stations shall be based on run requests, heating requests or cooling requests from zone controls. Reset of supply air static pressure, supply air temperature, chilled water temperature and hot water temperature shall be based on zone temperature conditions and heating or cooling requests from zones.

D SCHEDULING

For maximum flexibility all occupancy schedules shall be stored in zone control modules. Central fans or pumps shall start when commanded from any associated zones that call for occupancy or for operation to meet setback heating or cooling requirements and shall not require separate scheduling unless required for the sequence of operation. Fans or pumps larger than 5 horsepower shall run for minimum of 30 minutes.

E EQUIPMENT OPERATING SEQUENCES

See plans for sequence of operations and controls schematics.

END OF SECTION 230900

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SECTION 260500 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

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

B. Provisions of this Section shall apply to all Sections of Division 26, 27, and 28.

1.2 SCOPE OF WORK

A. Furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on the drawings and/or specified in all Sections of Division 26 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete installation, including all accessories required for testing the system. It is the intent of the drawings and specifications that all systems be complete and ready for operation.

1.3 CODE COMPLIANCE

A. All work and materials shall comply with the latest rules, codes and regulations, including, but not limited to, the following:

1. Occupational Safety and Health Act Standards (OSHA)
2. NFPA #70 – National Electric Code (NEC)
3. ADA Standards – Americans with Disabilities Act
4. ANSI/IEEE C-2 – National Electrical Safety Code
5. NECA – Standard of Installation
6. International Building Code
7. International Fire Code
8. International Energy Conservation Code
9. NFPA #72 – Fire Code
10. NFPA #101 – Life Safety Code
11. All other applicable Federal, State and local laws and regulations.

B. Work to be executed and inspected in accordance with local codes and ordinances. Permits, fees or charges for inspection or other services shall be paid for by the contractor. Local codes and ordinances are to be considered as minimum requirements and must be properly executed without expense to the owner; but do not relieve the contractor from work shown that exceeds minimum requirements.

1.4 CONDITIONS AT SITE

A. Visit to site is recommended of all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.

B. Lines of other service that are damaged as a result of this work shall be promptly repaired at no expense to the owner to the complete satisfaction of the owner.

1.5 DRAWINGS AND SPECIFICATIONS

A. All drawings and all specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.

B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assured. Exact requirements shall be governed by architectural, structural and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.

C. Change to location, type, function, brand name, finish, etc., shall not be made without permission of engineer.

D. Some equipment is specifically designated on the drawings. It is not the intent to sole source any item unless explicitly stated. Items have been specified based upon design requirements. All bidders are encouraged to submit products for approval. Prior approval must be obtained as required by these contract documents. Bids submitted with non-approved items will be considered invalid and bidders will be held to provide approved materials at no additional cost to the owner. Submittals received by the engineer after award of contract on non-approved equipment will not be reviewed nor will they be returned.

E. Where conflicting direction is given within the specifications and drawings, the contractor shall include the most expensive option in the bid.

1.6 SAFETY AND INDEMNITY

A. Safety: The contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours.

B. No act, service, drawing review or construction review by the owner is intended to include review of the adequacy of the contractor's safety measures in, on, or near the construction site.

1.7 CONSTRUCTION OBSERVATION BY THE ENGINEER

A. Prior to covering: any major portion of the materials installed under this section, notify the engineer so that an observation can be made. Notification shall be made at least three (3) working days in advance of the date the items will be covered.

1.8 INSTRUCTION OF OWNER'S PERSONNEL

A. The contractor shall conduct an on-site instructional tour of the entire project. The personnel designated by the owner shall be instructed in: operation of all electrical systems, trouble-shooting procedures, preventative maintenance procedures, uses of Operation and Maintenance manuals, maintenance and cleaning of lighting fixtures and operation of all special systems.

B. Contractor will include in his bid 8 hours of instruction time to be held at the project location after substantial completion for instruction of owner's personnel. Coordinate time and number of owner personnel to be present and provide schedule to engineer.

1.9 PROJECT COMPLETION

A. Upon completion of all work and operational checks on all systems, the contractor shall request that a final construction observation be performed.

B. The engineer shall compile a punch list of items to be completed or corrected. The contractor shall notify the engineer upon completion of the items.

1.10 GUARANTEE

A. All work under this section shall be guaranteed in writing to be free of defective work, materials, or parts for a period of one (1) year after final acceptance of the work under this contract or the period indicated under the Division 1 specifications whichever is longer.

B. Repair, revision or replacement of any and all defects, failure or inoperativeness shall be done by the contractor at no cost to the owner.

PART 2 - PRODUCTS

2.1 MATERIAL APPROVAL

A. The design, manufacturer and testing of electrical equipment and materials shall conform to or exceed latest applicable NEMA, IEEE or ANSI standards.

B. All materials must be new, unless noted otherwise, and UL listed. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency, which laboratory shall be acceptable to the owner and code enforcing agency.

2.2 SHOP DRAWINGS AND MATERIALS LIST

A. Submit an electronic copy, unless noted otherwise under Division 1, of the Division 26, 27 and 28 shop drawings and material lists proposed for this project to the architect/engineer for review.

2.3 OPERATION AND MAINTENANCE MANUALS

A. Submit an electronic copy, unless noted otherwise under Division 1, of the Operation and Maintenance Manuals for all Division 26, 27 and 28 equipment to the architect/engineer.

2.4 RECORD DRAWINGS

A. Submit record drawings to owner.

2.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials in a manner to prevent damage.

B. Protect equipment from weather and dampness.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

A. Only quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.

B. Provide experienced foreman with a minimum of three years experience working on this type of building placed in charge of this work at all times.

3.2 COORDINATION

A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under trades that require electrical connections. Inform contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without the authorization of the owner, shall be at contractor's risk and expense.

3.3 MANUFACTURER'S INSTRUCTIONS

A. All installations are to be made in accordance with manufacturer's recommendations. A copy of such recommendations shall at all times be kept in the job superintendent's office and shall be available to the engineer.

B. Follow manufacturer's instructions where they cover points not specifically indicated on drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the engineer before starting work.

3.4 QUALITY ASSURANCE

A. The contractor shall insure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

B. Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and special systems.

3.5 CUTTING AND PATCHING

A. Perform all cutting and fittings required for work of this section in rough construction of the building.

B. All patching of finished construction of building shall be performed under the sections of specifications covering these materials.

C. No joists, beams, girders or columns shall be cut by any contractor without obtaining written permission from the architect/engineer.

END OF SECTION 260500

SECTION 260501 – FIELD TEST AND OPERATIONAL CHECK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. 260502 – Coordination Study

1.2 SCOPE OF WORK

A. Ground resistance test.

B. 600V cable insulation test.

C. Main and distribution switchboard and panelboard operational check and test.

1.3 GENERAL SCOPE

A. The contractor shall engage and pay for the services of a recognized independent testing laboratory for the purpose of performing inspections and tests as specified in this Section.

B. The testing laboratory shall provide all material, equipment, labor and technical supervision to perform such tests and inspections.

C. These tests shall assure that all electrical equipment is operational within industry and manufacturer's tolerances, is installed in accordance with design specifications, and shall determine the suitability for energization.

D. The contractor shall schedule the tests and give a minimum of two weeks advance notice to the owner.

1.4 QUALIFICATIONS OF TESTING AGENCY

A. Testing agency shall be by Current Technologies Inc., the gear manufacturer, or approved equal agency.

1.5 TEST INSTRUMENT TRACEABILITY

A. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

B. Instruments shall be calibrated at the following frequency:

1. Field instruments: Six months maximum
2. Laboratory instruments: 12 months
3. Leased specialty equipment: 12 months (where accuracy is guaranteed by lessor, e.g. Doble)

C. Dated calibration levels shall be visible on all test equipment.

1.6 FINAL SETTINGS

A. The contractor shall set the protective devices in accordance with a short-circuit and protective device coordination report.

1.7 TEST REPORT

A. Submit copies of the test results to the owner. Test results shall be included in the project O &M Manuals.

B. The test report shall include a project summary, description of equipment tested, description of test, list of test equipment used and calibration date, test results, conclusions and recommendations, appendix (including appropriate test forms), and standards used.

C. The test report shall be bound and its contents certified.

1.8 FAILURE TO MEET TEST

A. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported directly to the owner.

B. Contractor shall replace the defective material or equipment and have test repeated until test proves satisfactory without additional cost to the owner.

PART 2 – PRODUCTS - Not Applicable

PART 3 - EXECUTION

3.1 GROUND RESISTANCE TEST

A. Building grounding electrode resistance testing shall be accomplished with a ground resistance direct-reading single test meter utilizing the Fall-of-Potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the concrete-encased ground electrode to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet deep.

B. Test results shall be in writing and shall show temperature, humidity and condition of the soil at the time of the tests. In the case where the ground resistance exceeds five (5) ohms, the owner will issue additional instructions.

3.2 600 VOLT CABLE INSULATION TEST

A. Megger and record insulation resistances of all 600 volt insulated conductors size 4/0 AWG and larger using a 500 volt megger for one minute. Conduct tests with circuits isolated from source and load.

3.3 MAIN AND DISTRIBUTION SYSTEM SWITCHBOARD AND PANELBOARD OPERATIONAL CHECK AND TEST

A. Check cleanliness of all interiors and all parts. Remove any excess packaging, shipping bolts, etc. Inspect for shipping damage.

B. Tighten all points of connection with torque wrench to values recommended by the manufacturer.

C. Verify proper operating condition of all equipment mechanically and electrically, including, but not limited to:

1. Wiring for all meters and instrumentation.
2. Verify operation of each circuit breaker trip device with an accurately metered timed instrument (by passing 300 percent rated current through each pole).
3. Verify relay operation by introduction of accurately metered currents into both overcurrent and ground fault circuitry at values which will enable accurate determination of the tripping coordination of main and feeder breakers. Provide this test with the tie breaker when provided.
4. Verify short time pick-up and delay, and instantaneous pick-up current. These should conform with manufacturer's published time current characteristic curves.
5. Auxiliary protective devices such as phase failure relays shall be activated to ensure operation.
6. Determine instantaneous pick-up current by primary injection using run-up or pulse method. Clearing time shall be within four (4) cycles.
7. Perform insulation resistance test per NASET specification section 2.
8. Measure the system neutral to ground resistance with neutral disconnect link removed, for ground fault protected systems.
9. Utilizing primary current injection, verify the breaker picks up and trips within the manufacturer's recommendations.
10. If the ground fault relay is external to the breaker or switch, ensure the operation at reduced voltage (60% for AC control and 80% for DC control).
11. Exercise all devices and components ensuring smooth operation.
12. Devices shall be tested upon settings defined by the breaker coordination study for this project.

D. If any equipment is found defective during operational check, it shall be replaced by the contractor without cost to the owner and tests repeated by the contractor, without cost to the owner, until satisfactory results are obtained.

END OF SECTION 260501

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SECTION 260502 –COORDINATION STUDY

PART 1: GENERAL

1.1 SCOPE

A. The contractor shall furnish a protective device coordination study as prepared by the electrical equipment manufacturer or a professional licensed engineer. The final report shall be stamped/singed by a professional engineer licensed in the state the project is located.

B. The scope of the study shall include all distribution equipment supplied under this contract.

1.2 RELATED DOCUMENTS

A. 260501 – Field Test and Operational Check

B. 262413 - Switchboards

C. 262416 – Panelboards

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the protective device coordination study shall be summarized in a final report. An electronic copy of the complete final report in PDF format shall be submitted.

B. The report shall include the following sections:

1. Executive Summary
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout
6. Details of the incident energy and flash protection boundary calculations
7. Recommendations for system improvements, where needed
8. One-line diagram
9. Arc flash labels shall be provided in hard copy.

1.6 QUALIFICATIONS

A. The protective device coordination study shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

1.7 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of:

1. SKM Systems Analysis Power*Tools for Windows (PTW) software program
2. Easy Power
3. Or Pre-Approved Software.

PART 2: PRODUCT

2.1 STUDIES

A. Contractor to furnish protective device coordination study as prepared by equipment manufacturer or an approved engineering firm.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the protective device coordination study shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
    a. Voltage
    b. Calculated fault current magnitude and angle
    c. Fault point X/R ratio
    d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
    a. Voltage
    b. Calculated symmetrical fault current magnitude and angle
    c. Fault point X/R ratio
    d. Calculated asymmetrical fault currents
        1. Based on fault point X/R ratio
        2. Based on calculated symmetrical value multiplied by 1.6
        3. Based on calculated symmetrical value multiplied by 2.7
    e. Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
    a. Voltage
    b. Calculated symmetrical fault current magnitude and angle
    c. Fault point X/R ratio
    d. No AC Decrement (NACD) Ratio
    e. Equivalent impedance
    f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
    g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
    a. Current transformer ratio
    b. Current setting
    c. Time setting
    d. Instantaneous setting
    e. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:
    a. Adjustable pickups and time delays (long time, short time, ground)
    b. Adjustable time-current characteristic
    c. Adjustable instantaneous pickup
    d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 EXECUTION

3.1. FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacture or the approved testing agencies listed in the related testing section(s).

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

END OF SECTION 260502

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SECTION 260519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

A. Submit shop drawings and product data.

1.4 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by the owner.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES

A. Conductors: Stranded, copper, 600-volt insulation, type THHN/THWN, THHN/THWN-2, XHHN/XHHW.

B. Conductors:

1. Solid or stranded for No. 10 and smaller, stranded for No. 8 and larger, copper, 600 volt insulation, type THHN/THWN. Aluminum conductors not allowed unless noted otherwise.
2. Insulation Types: THWN-2 for underground, THWN for wet locations, THHN for dry locations; XHHN/XHHW for GFI branch circuits and feeders fed from GFCI breakers.

C. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.
4. Neutral: White.
5. Ground: Green.
6. Isolated ground: Green with yellow tracer.

D. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Brown.
2. Phase B: Orange.
3. Phase C: Yellow.
4. Neutral: White or gray.
5. Ground: Green.

E. Wire connectors and splices: units of size, ampacity rating, material, type and class suitable for service indicated.

F. Signal and communication circuits:

1. Special cables as indicated on the drawings.
2. Conductors for general use: stranded copper conductor, #16 AWG minimum, with THWN-2 insulation for underground, THWN for wet locations and THHN insulation for dry locations.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Use no wire smaller than #12 AWG for power and lighting circuits and no smaller than #18 AWG for control wiring.

C. The contractor is responsible for upsizing conductor sizes to ensure the maximum voltage drop of any branch circuit does not exceed 3%. For reference, use No. 10 AWG conductor for 20 Amp, 120-volt branch circuits longer than 75 feet, and for 20 Amp, 277-volt branch circuits longer than 200 feet.

D. Place an equal number of conductors for each phase of a circuit in the same raceway or conduit.

E. Splice only in junction or outlet boxes.

F. Neatly train or lace wiring inside boxes, equipment, and panelboards.

G. Make conductor lengths for parallel circuits equal.

H. Provide a separate neutral conductor for each ungrounded conductor. Ungrounded conductors may share a neutral when all of the following conditions are met:

1. The ungrounded conductors are connected to a multi-pole breaker or breakers that are clipped together with a UL listed means that provide a common trip.
2. The ungrounded conductors contained in the same conduit or raceway.
3. The ungrounded conductors all originate from a separate and unique phase bus in the panel.

3.2 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions, and the “National Electrical Installation Standards" by NECA.

B. Remove existing wires from raceway before pulling in new wires and cables.

C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables above accessible ceilings; do not rest on ceiling tiles. Do not fasten cables to ceiling support wires. Use cable ties to support cables from structure.

3.3 CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splice and tap connectors compatible with conductor material.

D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

G. Terminate spare conductors with electrical tape.

3.4 LABELING

A. Provide Brady wire markers or equivalent on all conductors. All wire shall be labeled in each box and panel with the circuit number and panel identification.

3.5 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage.

B. Perform continuity testing on all power and equipment branch circuit conductors. Verify proper phasing connections.

END OF SECTION 260519

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SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Fixed Price Construction Contract and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to concrete encased electrode, metal underground water pipe, and effectively grounded metal frame of building.

B. Ground each separately-derived system neutral to nearest effectively grounded metal structural frame of building or point of service entrance ground.

C. Provide communications system grounding conductor to point of service entrance ground.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground connectors, and plumbing systems.

1.4 QUALITY ASSURANCE

A. Testing: Refer to Section 260501 – Field Test and Operational Check.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Section 260519 - Conductors and Cables.

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation. Where green insulation is not available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or device enclosure.

D. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

E. Bare Copper Conductors: Medium hard drawn copper conductor, stranded, sized as shown on the drawings.

F. Hardware: Bolts, nuts and washers shall be bronze; cadmium plated steel or other non-corrosive material, approved for the purpose.

G. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.2 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

D. Below grade compression fittings: Thomas & Betts, Series 52000, 53000, and 54000 or equivalent.

E. Use connector and sealant approved for purpose on all below grade clamp or compression type connections.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, 5/8 inch diameter, minimum length 8 feet.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NEC Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NEC are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways bonded to outlet or equipment, sized per Section 250 of the NEC.

G. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on grounding bar.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

H. Provide green insulated ground conductor to exterior post light standards.

3.3 INSTALLATION

A. Ground Rods: Where indicated, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, unless otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. UFER Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC 250, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 SYSTEM NEUTRAL GROUND

A. Ground the neutral conductor of each transformer or generator to limit the maximum potential above ground due to normal operating voltage and limit the voltage level due to abnormal conditions.

B. Ground transformers with secondary voltage 600 volt or less as follows:

1. 3 phase, 4 wire Wye connected: ground neutral point

C. For transformers 75 kVA or smaller with primary voltage 480 volt or less the primary equipment ground conductor may be used for grounding the secondary neutral provided it is adequately sized in accordance with NEC system ground conductor size.

3.6 EQUIPMENT GROUND

A. Ground non-current carrying metal parts of electrical equipment enclosures, frames, conductor raceways or cable trays to provide a low impedance path for line-to-ground fault current and to bond all non-current carrying metal parts together. Install a grounding conductor in each raceway system. Equipment grounding conductor shall be electrically and

mechanically continuous from the electrical circuit source to the equipment to be grounded. Size grounding conductors per NEC 250 unless otherwise shown on the drawings.

B. Install metal raceway couplings, fittings, and terminations secure and tight to ensure good grounding continuity. Provide grounding conductor sized per NEC through all raceway and conduit systems.

C. Lighting fixtures shall be securely connected to equipment grounding conductors. Outdoor lighting standards shall have a factory installed ground lug for terminating the grounding conductor.

D. Motors shall be connected to equipment ground conductors with a bolted solderless lug connection on the metal frame.

3.7 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Test ground system per Section 260501.

END OF SECTION 260526

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SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

A. Conduit and equipment supports.

B. Fastening hardware.

1.3 RELATED WORK

A. Division 3 - Concrete Work. Concrete equipment pads.

1.4 COORDINATION

A. Coordinate size, shape and location of concrete pads with Division 3.

1.5 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Support Channel: Galvanized or painted steel.

B. Hardware: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors or beam clamps. Do not use spring steel clips and clamps.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

D. Do not use powder-actuated anchors.

E. Do not drill structural steel members.

F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

G. In wet locations install free-standing electrical equipment on concrete pads.

H. Install surface-mounted cabinets and panelboards with minimum of four anchors.

I. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

J. All supports and attachments shall meet project seismic zone requirements.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RMC: Rigid metal conduit.

F. RNC: Rigid Polyvinyl Chloride conduit.

G. PVC: Rigid Polyvinyl Chloride conduit

H. HDPE: High Density Polyethylene Conduit

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. IMC: ANSI C80.6.

C. PVC coated Steel Conduit and Fittings: NEMA RN 1; rigid steel conduit with external 40 mil PVC coating and internal two mil urethane coating.

D. EMT and Fittings: ANSI C80.3. Fittings: Set-screw type.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.2 NONMETALLIC CONDUIT AND TUBING

A. RNC: NEMA TC 2, Schedule 40 PVC. Fittings: NEMA TC 3; match to conduit and material.

2.3 METAL WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Finish: Manufacturer's standard enamel finish.

2.4 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.

2.5 FLOOR BOXES

A. Floor Boxes: Cast metal, fully adjustable, rectangular, unless otherwise specified.

2.6 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 ENCLOSURES AND CABINETS

A. Hinged-Cover Enclosures: NEMA 250, Type 1, 3R, or 4, with continuous hinge cover and flush latch, key operable.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to

match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.8 J-HOOKS

A. J-hooks: Steel, rated for indoor use in non-corrosive environments. J-hooks shall be rated to support Category 5e cable.

B. Fittings and Support Bodies: Manufacturer's recommended fittings including side mount flange clips, bottom mount flange clips, beam clamp, rod and flange clip, C & Z purlin clip, and all other components and assemblies to make the system work.

C. Acceptable Product: Caddy CableCat Hanging System, 1-5/16" and 2" hooks, or approved equal

D. Acceptable Manufacturer: Erico Fastening Products or approved equal.

E. J-hook Supports: Manufacturer's recommended fastening devices.

2.9 INNERDUCT

A. Innerduct: NEMA TC 5. UL Listed, corrugated, specifically designed for optical fiber cable pathways.

B. Acceptable Manufactures: Arnco, Carlon, Dura-line, and Pyramid.

C. Composition:

1. Non-plenum rated: Polyethylene (PE), or High Density Polyethylene (HDPE).
2. Plenum rated: per manufacturer.

D. Nominal Size: 1" (inside diameter), minimum.

E. Pulling Strength: minimum of 600 pounds.

F. Color: Orange, solid.

G. Fittings and Innerduct Bodies: Manufacturer's recommended fittings including couplings, adapters, end caps, end bells, expansion couplings, plugs, sleeves, a full compliment of connective devices, and all other components to make the system work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

A. Outdoors: Use the following wiring methods:

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
4. Underground, Grouped: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

B. Indoors: Use the following wiring methods:

1. Exposed: EMT or "Wiremold" metallic raceways or equal.
2. Exposed in public areas: "Wiremold" metallic raceways or equal. Use of exposed raceways in public areas must be approved by the architect prior to installation for each location. Use of exposed EMT in areas visible to the public is not allowed unless specifically approved by the architect prior to installation. Replacement of unapproved installations of exposed raceways will be at the expense of the contractor if deemed necessary by the architect or engineer.
3. Concealed: EMT or MC-Cable. Note: MC-Cable is not approved for "homeruns"
4. Concealed in Patient Care Areas: EMT or Hospital Grade MC-Cable where allowed by code. Note: Hospital Grade MC-Cable is not approved for "homeruns"
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
6. Damp or Wet Locations: Rigid steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
   a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Minimum Raceway Size: 1/2-inch trade size. 3/4-inch minimum for "homeruns".

C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation.

G. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

H. Use temporary closures to prevent foreign matter from entering raceways.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

K. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

M. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
4. Transition from nonmetallic tubing to rigid steel conduit or IMC before rising above floor.

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

O. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

P. Tighten set screws of threadless fittings with suitable tools.

Q. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

R. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

S. Install pull wires in empty raceways. Utilize polyester line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

T. Telephone and Signal System Raceways: In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

U. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
2. Where conduit pass from the interior to the exterior of a building.
3. Where otherwise required by NEC.

V. Apply firestopping to cable and raceway penetrations of fire-rated floor, ceiling, and wall assemblies to achieve fire-resistance rating of the assembly. Boxes installed in fire-rated floor, ceiling, and wall assemblies shall result in no larger than a 16 square-inch penetration in the fire-rated wall surface and the quantity of penetrations shall not be greater than 100 square-inches for every 100 square feet of fire-rated wall area. Where boxes are located on both sides of a fire-rated

wall, the boxes shall have a minimum of a 24" horizontal spacing, where a 24" horizontal spacing cannot be achieved, furnish and install listed fire-rated putty on the boxes as required by the IBC.

W. Route conduit through roof openings for piping and ductwork where possible; otherwise, install roof penetrations in accordance with roofing system requirements. Coordinate with roofing installer.

X. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.

Y. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

Z. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

AA. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.

BB. Conduits shall not be routed on or above the roof without prior approval from the Engineer. Instead, the branch circuits shall be routed at the structure level below the roof to feed roof-top equipment. When approval is granted to route conduits on or above the roof, the conduits shall be strapped to COOPER industries DB series support blocks at intervals not exceeding NEC requirements. The conduits shall not be rested directly on the roof. It shall be permissible to penetrate the roof adjacent mechanical or electrical equipment to power that respective equipment.

3.4 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers, at least every 8 feet.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards; disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit. Perform fastening according to the following unless other fastening methods are indicated:

1. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
2. New Concrete: Concrete inserts with machine screws and bolts.
3. Existing Concrete: Expansion bolts.
4. Steel: Spring-tension clamps on steel.
5. Light Steel: Sheet-metal screws.
6. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

N. Do not drill structural steel members.

O. All supports and attachments shall meet project seismic zone requirements.

3.5 BOX INSTALLATION

A. Do not install boxes back-to-back in walls.

B. Locate boxes in masonry walls to require cutting of masonry unit edge only. Coordinate masonry cutting to achieve neat openings for boxes.

C. Provide knockout closures for unused openings.

D. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.

E. Use 4” boxes with multiple-gang mudring where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

F. Install boxes in walls without damaging wall insulation.

G. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

H. Position outlets to locate lighting fixtures as shown on reflected ceiling plans.

I. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

J. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud walls, and adjustable steel channel fasteners for flush ceiling outlet boxes.

K. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

L. For boxes installed in metal construction, use rigid support metal bar hangers or metal bar fastened to two studs or with metal screws to metal studs.

M. Set floor boxes level and adjust to finished floor surface.

N. Set floor boxes level and trim after installation to fit flush to finished floor surface.

O. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

P. Locate pull and junction boxes above accessible ceilings or in unfinished areas. Support pull and junction boxes independent of conduit.

Q. Minimum box size to be 4" square by 2 1/8" deep.

3.6 LABELING

A. Label coverplate of all pull and junction boxes by system served. Indicate panel circuits for power and lighting boxes.

3.7 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 260533

SECTION 260536 - CABLE TRAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes cable trays and accessories.

1.3 SUBMITTALS

A. Submit shop drawings, product data, manufacturer's installation instructions and maintenance manuals.

1.4 COORDINATION

A. Coordinate layout and installation of cable tray with other installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: B-Line Systems, Inc. P-W Industries, Inc., or approved equal.

2.2 CABLE TRAYS

A. Above accessible ceilings: 4-inch-deep, width as indicated on the drawings, basket type.

B. Above data racks: Aluminum, 4-inch-deep, width as indicated on the drawings, ladder type, six inch rung spacing.

C. Fabricate cable tray products with rounded edges and smooth surfaces.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as required, of same materials and finishes as cable tray, to form a continuous cable tray system.

B. Barrier Strips: Where indicated on the drawings; same materials and finishes as cable tray.

C. Cable tray supports and connectors as recommended by cable tray manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cable tray in accordance with manufacturer's written instructions.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports securely to building structure as specified.

D. Install expansion connectors where cable tray crosses a building expansion joint and in cable tray runs that exceed 90 feet.

E. Make changes in direction and elevation using standard fittings.

F. Make cable tray connections using standard fittings.

G. Workspace: Install cable trays with sufficient space to permit access for installing cables.

3.2 CLEANING

A. On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

END OF SECTION 260536

SECTION 260543 – UNDER SLAB AND UNDERGROUND ELECTRICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes under slab conduits and related electrical work.

PART 2 - PRODUCTS

2.1 CONDUIT

A. All shall be provided with fittings and accessories approved for the purpose. Refer to Section 260533.

2.2 BARE COPPER GROUND CONDUCTOR

A. Medium hard drawn copper conductor, # 4/0 AWG stranded (unless otherwise noted).

PART 3 - EXECUTION

3.1 GENERAL

A. Electrical system layouts indicated on the drawings are generally diagrammatic but shall be followed as closely as actual construction and work of other trades will permit.

3.2 CONDUIT INSTALLATION

A. Plastic conduit shall be installed on 2-inch sand base and covered by 2-inch sand back fill. Multiple runs shall maintain 3-inch minimum separation between runs. Plastic conduit shall not be installed in rock base.

B. Underground conduit entering building shall be provided with one 10-foot section of rigid steel conduit at point of penetration of foundation, footing or basement wall, with approximately equal lengths inside and outside building line. Ream the smaller inside diameter conduit smooth to prevent conductor damage.

C. Stagger conduit couplings by a minimum of 12 inches. All risers to grade shall be rigid steel.

D. All rigid steel conduits shall be encased in 3-inch minimum concrete envelope.

E. After completion of concrete encased duct bank, a 12-inch mandrel, ¼ inch less in diameter than a conduit, shall be pulled through each conduit.

F. Install 1/8-inch diameter pull line in each underground conduit.

G. Burial depths of conduits shall comply with the NEC (minimum).

H. Provide underground type plastic line markers: permanent, brightly colored, continuously printed plastic tape, intended for direct burial service, not less than 6 inches wide, reading “Caution Buried Electrical Line.” Install continuous line markers located directly over buried line at 6 inches above top of conduit, during back filling operation.

END OF SECTION 260543

SECTION 260800 – LIGHTING SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. This Section includes requirements for commissioning the lighting system and its controls.

B. The registered design professional is responsible to provide evidence of lighting systems commissioning and completion in accordance to the provisions of this section.

1.3 DEFINITIONS:

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. RDP: Registered Design Professional

C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

1.4 COMMISSIONING DOCUMENTATION:

A. Commissioning Plan: A commissioning plan will be developed by a registered design professional or approved agency and shall include the following items:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.

2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.

3. Functions to be tested.

4. Conditions under which the test will be performed.

5. Measurable criteria for performance

B. Test Checklists: RDP, with assistance of Architect/Engineer, shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist.

1. Name and identification of tested item.
2. Test number.
3. Time and date of test.
4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
5. Date of the test and name of parties involves as applicable.
6. Individuals present for test.
7. Deficiencies/Issues/Results of test.
8. Note if re-test is necessary.

C. Test and Inspection Reports: RDP shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. RDP shall compile test and inspection reports and tests and inspection certificates and include them in systems manual and commissioning report.

D. Corrective Action Documents: RDP shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

E. Issues Log: RDP shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.

1. Creating an Issues Log Entry:
    a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
    b. Assign a descriptive title of the issue.
    c. Identify date and time of the issue.
    d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
    e. Identify system, subsystem, and equipment to which the issue applies.
    f. Identify location of system, subsystem, and equipment.
    g. Include information that may be helpful in diagnosing or evaluating the issue.
    h. Note recommended corrective action.
    i. Identify commissioning team member responsible for corrective action.
    j. Identify expected date of correction.
    k. Identify person documenting the issue.

2. Documenting Issue Resolution:
    a. Log date correction is completed or the issue is resolved.
    b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
    c. Identify changes to the Contract Documents that may require action.
    d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
    e. Identify person(s) who corrected or resolved the issue.
    f. Identify person(s) documenting the issue resolution.

3. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, RDP shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, RDP shall include the following information in the issues log and expand it in the narrative:
    a. Issue number and title.
    b. Date of the identification of the issue.
    c. Name of the commissioning team member assigned responsibility for resolution.
    d. Expected date of correction.

F. Commissioning Report: RDP shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report shall include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances in the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
2. Commissioning plan.
3. Testing plans and reports.
4. Corrective modification documentation.
5. Issues log.
6. Completed test checklists.

G. Systems Manual: RDP shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:

1. Submittal Data stating equipment installed and selected options for each piece of equipment requiring maintenance.
2. Operation and maintenance data on each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.
3. Name and address of at least one service agency.
4. Lighting controls system maintenance and calibration information.
5. A narrative of how each system is intended to operate, including recommended setpoints.

PART 2 – PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 TESTING:

A. Testing shall ensure that the control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturers installation instructions.

B. Testing shall ensure that the lighting controls meet all provisions of the applicable energy code.

C. Perform tests using design conditions whenever possible. Where occupant sensors, time switches, programmable schedule control, photosensor's or daylighting controls are installed, the following procedures shall be performed:

1. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.
2. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.
3. Confirm that the placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space as specified.

END OF SECTION 260800

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SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.

B. Related Sections include the following:

1. Section 262726 - Wiring Devices for wall-box dimmers and manual light switches.

1.3 SUBMITTALS

A. Submit shop drawings and product data, including all wiring diagrams.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449.

2.2 TIME SWITCHES

A. Description: Electromechanical-dial type complying with UL 917.

1. Astronomic dial.
2. Two contacts, rated 30 A at 277-V ac, unless otherwise indicated.
3. Eight-day program uniquely programmable for each weekday and holidays.
4. Skip-day mode.

2.3 LIGHTING CONTROL SYSTEM

A. Description of Work: The lighting control system for interior common areas and the exterior of the building shall be provided as part of the DDC system furnished by the DDC contractor. The extent of lighting control system work is indicated by drawings, and by the requirements of this section. It is defined to include low voltage lighting control panels, switch inputs and wiring.

B. SYSTEM DESCRIPTION

1. The lighting control system shall consist of low voltage relay control panels with 32 programmable switch inputs and shall offer 32 control relays.
2. Each low voltage lighting control panel shall be microprocessor controlled with an integral 4 x 16 - 64 character display and with a programming keypad.
3. Programmable intelligence shall include Time-Of-Day control, 32 holiday dates, warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control.

TOD	64 Time-Of-Day/holiday schedules for 365 day programming
Holidays	32 holiday dates
Warn Off	Flash lights and provide an extra 1 second to 99 minutes of illumination
Preset	Pre-programmed switch patterns
Timed Inputs	Switch input timers 1-999 minutes
Timed Overrides	Timed override 1-999 minutes, resumes to normal schedule
Local Control	From alpha-numeric keypad & local switch
Astronomical	Longitude and latitude input with sunset-sunrise offsets to customize outdoor lighting Clock
Auto Daylight	Automatically adjusts the clock at the appropriate dates, selectable Savings Adjust.
Priorities	Establishes a hierarchy for inputs and network control commands
Masking	Provides permission orientation to switch inputs and network commands thereby ensuring building lighting control integrity.
Soft-Linking	Group linking for rapid programming

4. Relays may be designated as either normally open or normally closed from software. Relay status shall not only disclose commanded relay status but next scheduled state to occur.
5. Each control panel shall provide a Warn Off (flash the lights) to inform the occupants of an impending Off command. The Warn Off command shall provide an adjustable time duration of 1 second to 99 extra minutes. The occupants may exit the premises with adequate lighting or cancel the Warn Off by overriding the lighting zone. This option occurs with all Off commands except local overrides.
6. The controller shall permit lighting to be overridden on for after hours use or cleaning. The controller shall provide optional switch timer assignments or timed overrides. The override choices for various relays shall provide special event occurrences and the controller shall return to the programmed state. Also, the controller shall provide priority and masking choices to customize the functions of switch inputs, thereby enabling switches to function differently at different times of the day to meet special facility operational requirements. These overrides shall be hard-wired inputs.
7. Programming the controller shall be through the local integral keypad. Descriptive information shall assist the user to employ the system without a programming manual.
8. Priorities and/or Masking shall be assigned to inputs, telephone override, and global commands to insure building integrity. Priorities enable or disable the inputs based on Time-Of-Day scheduling in the controller. Masks shall permit: On only, Off only and On & Off control for intelligent after hours utilization of the controlled facility
9. The lighting control system may be fully programmed through PC programming software. Programming shall be permitted through a direct RS-232 or RS-485 connection, and modem.

C. HARDWARE FEATURES

1. Operator Interface: The control panel programming interface resides in firmware in the control panel. The programming interface shall consist of a circuit board mounted keypad capable of

linking switch inputs to relay outputs and schedule assignments. Systems that utilize blocking diode technology for relay assignments shall not be acceptable.

The integral keypad shall provide access to the main programming features. The keypad shall permit the user to manually command any or all relays individually. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted.

2. Contact inputs: The control system shall permit 32 dry contacts (Digital/Switch Inputs) for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Maintained contacts shall be supported as 2 wire (SPST) inputs. Inputs shall be dry contacts (24 VDC @ 12 ma. internally supplied to the inputs). An input shall be software linked to any number of relays for override control.

   The controller shall provide timers for each switch input. Each switch input timer shall be capable of 0-999 minutes. Software shall enable or disable switch inputs based on Time Of Day scheduling.

3. Relay Type: The system shall utilize control relays which are rated to 20 amps at 277 VAC. The relays shall be magnetically held and are provided in groups of eight. Relays that are latched or mechanically held are not acceptable. The relays shall be rated for 10 million mechanical operations. A limited 10 year warranty shall be provided on the individual relays.
4. Photocell Control: The controller shall accept user adjustable ambient light sensors. The controller shall provide power for the sensor thereby eliminating any external power supply. Sensors shall provide for both outdoor and indoor applications and provide a dry contact to the controller once the threshold is reached. The sensor shall provide user adjustable dead band control.
5. Modular Design: The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on quick release hinge pins that shall permit an entire change out of the processor and input board in less than 1 minute.

   All connections for the switch inputs shall incorporate modular connectors. The relay board shall be modular and designed for rapid field replacement or upgrading. Systems that do not employ modular connectors shall not be acceptable.

6. Hardware Output Options
   a. Latching Relay Card (LRC): The controller shall provide an option for remote placement of the control relays. A modular card shall connect into the relay compartment. Twisted (3) conductor cable shall power and control the remote mounted relays. Maximum distance is 500 feet employing 18 AWG conductor.
   b. Modular Relay Card (MRC): The controller shall provide an option for modular relay control. The Modular Relay Card (MRC) shall offer the feature of controlling two pole voltages such as 208, 240, and 480VAC in a Normally Open or Normally Closed configuration. Single pole is offered for 120 and 277VAC in a Normally Open and Absolute Zero Configuration. This relay card shall also provide visual indication of relay status. Relays shall be individually exchangeable with plug in low voltage connectors. Combinations of relays shall be permitted since relay modules shall snap into and lock in location. Two pole modules require two relay locations for a maximum of four two pole relays per card. All other relay modules use 1 relay location for a maximum of eight per card. All Modular Relay Card components shall be warranted for 10 years.
   c. Two Pole Relay Card (TPRC): The controller shall provide an option for two pole relay control. The Two Pole Relay Card TPRC shall offer the feature of controlling two pole voltages such as 208, 240, and 480 VAC lighting loads at 20 amps. The relays shall be modular in design and offer manual hand override control. This optional relay card shall also provide a visual indication of relay status. The 208, 240 VAC version shall provide 8 relays per card whereas the 480 VAC version shall provide 4 relays per card. Combinations of relays shall be permitted since relays shall snap into location.
   d. Automatic Relay Card (ARC): The system shall utilize hybrid control relays that are rated to 20 amps at 277 VAC. The hybrid relay shall combine a high speed electronic switch with a mechanical relay to create a unique switching device. The hybrid design shall look at each

AC phase and shall close the electronic switch precisely at the absolute zero crossing. The mechanical relay in parallel shall follow and close after the in-rush current condition. The relay shall provide an integral switch for both manual hand operation and visual indication of relay status. The relays shall be rated for 10 million mechanical operations. A limited 2 year warranty shall be provided on the individual relays.

e. Lighted Switch Card (LSC): The controller shall provide an option for pilot light wall switch annunciation. A modular card shall connect into the controller board and shall provide power to illuminate pilot light switches. This option shall confirm relay operation. When a relay is in the "ON" position the pilot light switch shall be illuminated.

7. Diagnostic Aids: Each control panel shall incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids shall guide the individual in rapid troubleshooting of the system.

   The control panels shall employ both a backlit supertwist LCD and LED's that indicates:
   - POWER (LED)
   - SYSTEM OK (LED)
   - NETWORK COMMUNICATIONS (LED)
   - ON/OFF STATUS of EACH RELAY (LED & LCD)
   - SYSTEM CLOCK and DATE (LCD)
   - PROGRAMMING CONFIRMATION (LCD)
     (TOD, HOLIDAY, ON/OFF, & PRESET)

   Control systems that do not provide visual self help diagnostics shall not be acceptable.

8. Memory Back-up: The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable. The data in RAM shall be protected against power interruptions lasting as long as 7 days. The power interrupt protection circuit shall be entirely maintenance-free.

9. Multi-tapped Transformer: The control panel shall incorporate the use of a multi-tapped transformer. The panel shall not require specification of voltage for each control location. The voltages of 120 & 277 VAC shall be available with each control panel.

10. Status Indication of Relays: The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose On/Off status and relay number.

11. Service Override & Priority Override: The control panel shall provide a three position master-service override for the control unit. The service override shall not be accessible from the exterior.

    The master service override provides a single three position switch with the option of All Off, Auto, and All On, respectively. This master switch shall operate all of the relays in the controller. This switch shall override and supersede all commands from the logic board when the switch is in the All On or All Off position. The master switch shall function to override all the relays should the logic board programming differ from the space function.

    The system shall remember the last command to the individual relays. Upon returning the master override switch to the Auto position, the relays shall return to the most recent command state. This will occur even if the last command happened during the master override condition.

    Additionally, the system shall provide external priority override for the entire panel. Through an externally maintained contact the override card shall place the panel in a priority state. This external contact will supersede any other programmed state and will command all the relays ON or OFF depending on operational choice. This priority state will continue until the external contact is removed. Once the external override is removed the control panel will return the relays to the appropriate programmed state.

12. Lockable Enclosure: Each control panel shall be enclosed in a lockable NEMA class 1 enclosure. The enclosure shall be manufactured out of 1/16" steel and shall provide pre-punched knockouts for efficient installation.

13. Panels: The low voltage controller shall exist in two sizes of relay enclosures. The enclosure maximum sizes shall be 32 relays per cabinet. The 16 size will employ two relays cards and the 32 will utilize 4 relay cards. Relays shall be provided in groups of eight relays per card.

14. High Voltage Barriers: The low voltage controller shall provide as an option the ability to provide a barrier for either voltage separation or emergency circuit separation. The 16-size enclosure shall permit one barrier and the 32-size enclosure shall permit up to three locations where the barrier(s) may be installed. The barrier shall be painted red to denote the difference.
15. Modem: The control system shall be capable of modem communications. Each control panel shall provide a serial communications port for external tele-communications. The modem shall utilize the Hayes compatibility standard and enable modem access as defined by the Bell 212A and CCITT V.22 protocol standards.
16. Telephone Overrides (TIM): The control system shall provide intelligent software for the Telephone Interface Module (TIM) option. The optional TIM unit shall allow modem communications and touch tone overrides from any touch tone phone. The control system shall be multi-tasking and permit up to one TIM for each control panel.

    Override Operation: Touch-tone interface shall permit the control panel to command pre-assigned control points On\ Off. All user interfaces shall be through the twelve Touch-tone keys on the telephone. All entries into the override system shall be prompted by a digitized voice. Systems not employing voice guided override instruction are not acceptable.

    The TIM shall provide individual control passwords. Each password shall allow a preset group designation (number of relays) and the duration of the telephone override. TIM shall also provide a password to prevent entry into the override control system.
17. Software: System provided shall include the manufactures PC based interface software package. The PC based interface software shall provide access to lighting control system files within a Microsoft Windows environment. The software package shall allow individual panel programming to be executed locally, direct connection, Ethernet connection or remotely through a modem. The central programming software shall permit the user to modify the control panel programming or configuration in an "OFF-LINE" mode. This software package shall store all programmed data and archive for future use. Systems using third party software are not acceptable.

    The following features shall be standard in the PC based software:

    a. Standard Software Features:
        i. Real Time Relay Status Monitoring
        ii. Alpha-Numeric Descriptors
        iii. Communications: Direct, Network, Ethernet and Modem
        iv. Network Status Indication
        v. Global Software Modifications
        vi. Manual Relay Commands
        vii. Remote Pattern Commands
        viii. Preset Options

    b. File Maintenance
        i. Archive Programs
        ii. Data Base Restoration
        iii. Uploading and Downloading of Programs

    Software package shall permit the PC to be utilized for other functions (i.e. word processing, data-base, & etc..) besides lighting control. Systems that require an "on-line" dedicated computer for control system operation shall not be acceptable.

18. PC Interface (RS-232 port): The controller shall permit PC programming through software. The controller shall provide a RJ-12 connection for RS-232 programming. Programming shall be permitted through either a local connection or remotely through a modem. PC software shall permit multiple file storage for data archival and for seasonal facility requirements. Operator commands may be issued directly from the PC keyboard.

D. WARRANTY

1. Manufacturer shall supply a 2 year warranty on all hardware and software. A limited 10 year warranty shall be provided on the standard relay card.

2.4 PHOTOELECTRIC RELAYS

A. Description: Solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A.

B. Light-Level Monitoring Range: 0 to 3500 fc, with an adjustment for turn-on/turn-off levels.

C. Time Delay: Prevents false operation.

D. Outdoor Sealed Units: Weather tight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer.

2.5 OCCUPANCY SENSORS

A. Occupancy sensors indicated on the plans are to establish room controls and sensor quantities. The contractor is to verify sensor placement with the local manufacturer's representative or the manufacture to ensure proper coverage and functionally of the specific sensor(s) installed. The contractor is to return and make any adjustments necessary to the occupancy sensor settings and/or placement needed to maintain proper functionality within 30 days after the owner/tenant takes occupancy of the project.

B. Lighting control system shall include all occupancy sensors, power packs, and control wiring required to form a complete system.

C. All occupancy sensors shall be dual/multi technology, manufactured by Unenco, Wattstopper, Lightolier Controls, Sensor Switch, or pre-approved equal unless otherwise noted.

D. Ceiling and Wall Mount Units: Shall utilize dual/multi technology detection methods. Unit receives control power from a separately mounted auxiliary power and control unit and operates power switching contacts in that unit.

E. Switch-Box-Mounting Units: Shall utilize dual/multi technology detection methods. Unit receives power directly from switch leg of the 120- or 277-V ac circuit it controls and operates integral power switching contacts. Unit is to have integral manual controls and is to be mounted at standard switch height.

F. Operation: Turns lights on when room or covered area is occupied and off when unoccupied, unless otherwise indicated.

1. Time Delay for Turning Lights Off: Adjustable over a range from 1 to 20 minutes, minimum. Time delay to be set at 20 minutes unless otherwise directed. Contractor shall verify time delay with the owner/tenant prior to final occupancy.
2. Manual Override Switch: Where indicated on drawings; turns lights off manually regardless of elapsed time delay.
3. Sensor shall be located and/or adjusted to detect occupancy within 1-foot of entry into room or area controlled by the occupancy sensor.

G. Auxiliary Power and Control Units: As follows:

1. Relays rated for a minimum of 20-A normal ballast load.
2. Sensor Power Supply: Rated to supply the number of connected sensors.

3. Relays shall have an auxiliary contact(s) for integration with HVAC or other building control systems.

H. Passive-Infrared Type: Detects occupancy by a combination of heat and movement in zone of coverage.

I. Ultrasonic Type: Emits a beam of ultrasonic energy and detects occupancy through use of Doppler's principle in discerning movement in zone of coverage by sensing a change in pattern of reflected ultrasonic energy. Ultrasonic frequency shall be 25 Khz or greater and sensor shall be temperature and humidity resistant.

J. Dual-Technology Type: Uses a combination of passive-infrared and ultrasonic or microphonic detection methods to distinguish between occupied and unoccupied conditions for area covered. Particular technology or combination of technologies that controls each function (ON or OFF) is selectable in the field by operating controls on unit.

K. All sensors shall be capable of operating normally with electronic ballast and compact fluorescent systems.

L. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

M. All sensors shall have readily accessible, user adjustable controls for time delay and sensitivity. Controls shall be recessed to limit tampering.

N. In the event of failure, a bypass manual “override on” feature shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly. The override feature shall be designed for use by building maintenance personnel and shall not be readily accessible by building occupants.

O. All sensors shall provide an LED indication light to verify that motion is being detected and that the unit is working.

P. All sensors shall have no leakage current in OFF mode and shall have voltage drop protection.

2.6 MULTIPOLE CONTACTORS AND RELAYS

A. Description: Electrically operated and mechanically held and complying with UL 508 and NEMA ICS 2.

1. Current Rating for Switching: UL listing or rating consistent with type of load served.
2. Control Coil Voltage: Match control power source.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions.

B. Wiring Method: Install all wiring in raceways.

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 IDENTIFICATION

A. Provide Brady wire markers or equivalent on all conductors.

3.4 FIELD QUALITY CONTROL

A. Inspect control components for defects and physical damage.

B. Verify settings of photoelectric devices with photometer.

C. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

D. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

E. The Lighting Control Panel shall be tested and listed under the UL 906 Energy Management Equipment Standards.

3.5 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

END OF SECTION 260923

SECTION 262200 - DRY-TYPE TRANSFORMERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes dry-type distribution and specialty transformers rated 1000 V and less.

1.3 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Factory Test Reports: Copy of manufacturer's design and routine factory tests required by referenced standards.

D. Sound-Level Test Reports: Copy of manufacturer's sound-level tests applicable to equipment for this project.

E. Maintenance Data: For transformers.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide transformers specified in this section that are listed and labeled as defined in the NEC.

B. Equipment shall conform or exceed requirements of NEMA, ANSI Standard C89.2 for dry-type transformers for general applications.

C. Comply with the NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Cutler-Hammer/Eaton Corp.
2. GE Electrical Distribution & Control.
3. Square D; Groupe Schneider.
4. Siemens
5. Or approved equal.

2.2 TRANSFORMERS, GENERAL

A. Description: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, nonaging silicon steel.

C. Coils: Continuous windings without splices, except for taps.

D. Internal Coil Connections: Brazed or pressure type.

E. Enclosure: Class complies with NEMA 250 for the environment in which installed.

F. Low-Sound-Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

A. Comply with NEMA ST 20 and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Windings: One coil per phase in primary and secondary.

D. Electrical ratings:

1. Primary winding voltage: 480 volts, 3 phase, delta.
2. Secondary winding voltage: 120/208 volts, 3 phase grounded wye.
3. KVA rating: As indicated on drawings.

E. Enclosure: Indoor, ventilated.

F. Temperature classification:

1. Winding temperature rise shall be 150 degrees C in accordance with UL specification 506 with insulation Class 220 degree Celsius.

G. Load rating:

1. Transformer shall be capable of operating at 100% of nameplate rating continuously while in an ambient temperature not exceeding 40 degrees C.
2. Transformer shall meet the daily overload requirements of ANSI Standard C57.96.

H. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:

1. Taps, 3 through 10 kVA: Two 5-percent taps below rated high voltage.
2. Taps, 15 through 500 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
3. Taps, 750 kVA and Above: Four 2.5-percent taps, 2 above and 2 below rated high voltage.

I. K-Factor Rating: Transformers indicated to be K-factor rated are listed to comply with UL 1561 requirements for nonsinusoidal load current handling capability to the degree defined by the designated K-factor.

1. Transformer design prevents overheating when carrying full load with harmonic content corresponding to the designated K-factor.
2. Nameplate states the designated K-factor of the transformer.

J. Vibration Isolation:

1. Provide neoprene rubber pads to isolate core and coil assembly from transformer enclosure.

K. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 75 kVA.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2 windings.

2.5 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests comply with referenced standards.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this project if specified sound levels are below standard ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

C. Anchor transformer securely with minimum ½" diameter bolts. Strength of bolts used to secure the transformer shall be sufficient to resist shear and uplift produced by a force equal to one half of the equipment mass applied horizontally at the center of gravity.

D. Provide 1" thick resiliency pads to isolate transformer from floor or platform, Korfund "Elasto Rib" or equal.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

F. The grounding conductor for each transformer shall be routed back to the Main Grounding Bar used for the building ground system.

3.2 GROUNDING

A. Separately Derived Systems: Comply with the NEC requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

B. Comply with Section 260526 - Grounding for materials and installation requirements.

3.3 CONNECTIONS

A. Use flexible conduits at least 24" long for electrical connections.

3.4 IDENTIFICATION

A. Provide engraved lamacoid nameplate for each transformer.

3.5 FIELD QUALITY CONTROL

A. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the contract documents, and is suitable for energizing.

B. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values.

C. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.6 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.7 ADJUSTING

A. After installing and cleaning, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit to owner.

C. Adjust buck-boost transformer connections to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility.

END OF SECTION 262200

SECTION 262413 –SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes main switchboards.

B. Related sections:

1. Section 260501 - Field Test and Operational Check.
2. Section 260526 - Grounding.

1.3 REFERENCES

A. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 2 - Dead Front Distribution Switchboards.

D. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, one line and wiring diagrams, and time-current curves of all equipment and components.

C. Field test reports – See Section 260501.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data. Include the following:

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 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 NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 SPARE PARTS

A. Keys: Furnish 3 each to owner.

B. Fuses: Furnish to owner 3 spare fuses of each type and rating installed.

C. Fuse Pullers: Furnish one fuse puller to owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General Electric, Cutler-Hammer, Siemens, Square D Co.; Schneider Electric Brands, or approved equal.

2.2 SWITCHBOARD CONSTRUCTION AND RATINGS:

A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB 2, and complete from incoming line terminals to load-side terminations. Provide lugs appropriate for conductors used.

B. Switchboard electrical ratings and configurations as shown on Drawings.

C. Equipment shall be fully rated to interrupt symmetrical short-circuit current available at terminals or the rating indicated on the plans, whichever is higher. Series rating is not acceptable unless specifically indicated on the plans.

D. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials used.

E. Bus Material: Copper sized in accordance with NEMA PB 2.

F. Bus Arrangement: Use A-B-C sequence in left-to-right, top-to-bottom, and front-to-rear arrangement throughout.

G. Bus Connections: Bolted, accessible from front or rear for maintenance.

H. Enclosure shall be NEMA PB 2 Type 1 - General Purpose. Sections shall align at front and rear. Provide NEMA 3R Enclosure when indicated on plans.

I. Switchboard Height (NEMA 1): 90 inches, excluding floor sills, lifting members and pull boxes.

J. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion resisting paint, or plate with cadmium or zinc.

K. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on Drawings.

2.3 SWITCHING AND OVERCURRENT PROTECTIVE DEVICES-

A. Main Circuit Breaker Assemblies:

1. Main Circuit breakers (unless otherwise indicated on plans) shall be insulated case type as indicated on plans with temperature insensitive, solid-state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination.
2. All Main Circuit Breakers rated for 1200 Amp or higher shall have the following features:

   a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
   b. Adjustable [L] Long time time-delay and ampere setting.
   c. Adjustable [S] Short time-delay and pick-up.
   d. Adjustable [I] Instantaneous trip.
   e. Adjustable [R] Reduced Energy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
   f. For 277/480Y systems rated 1000 Amp or higher - Adjustable [G] Ground fault pick-up and delay is required.
   g. Where indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
   h. Short circuit, overload and ground fault trip indicators.
   i. Trip device of circuit breakers shall be of the same type for tripping coordination and shall allow for the UL listed field installation of internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Breaker shall include Accessories as indicated on plans.
   j. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or ' OFF' position.

B. ALL Feeder Breaker Assemblies 1200 Amp and above:

1. Feeder Circuit breakers 1200 Amp may be Molded Case or Individually Mounted, 1600 Amp and above shall be Insulated Case with temperature insensitive, solid-state trips, current sensors and solid-state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit breakers shall have the following features:

   a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
   b. Adjustable [L] Long time time-delay and ampere setting.
   c. Adjustable [S] Short time-delay and pick-up.
   d. Adjustable [I] Instantaneous trip.
   e. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.

f. Adjustable [R] Reduced Entergy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
g. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
h. Short circuit, overload and ground fault trip indicators.

C. Feeder Circuit Breaker Assemblies below 1200 Amp:

1. Feeder Circuit breakers below 1200 Amp shall be digital solid state true RMS sensing Molded Case Circuit Breakers with temperature insensitive, solid-state trips, current sensors and solid-state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit Breakers shall have the following minimum features:

a. UL listed for 80 percent load application unless otherwise indicated on plans.
b. Long time pickup (ampere setting) determined by interchangeable rating plug.
c. Adjustable instantaneous with short time tracking function.
d. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
e. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or 'OFF' position

2. Where specifically indicated or required by NEC

a. Adjustable [L] Long time time-delay and ampere setting.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
e. Where indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
g. Trip device of circuit breakers shall be of same type for tripping coordination.

D. Feeder Circuit Breaker Assemblies 150 Amp and below:

1. Feeder Circuit breakers 150 Amp and below shall be thermal Magnetic Circuit breaker: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits, unless otherwise indicated or required to meet Section 2.4 C above. Minimum features below:

a. UL listed for 80 percent load application unless otherwise indicated on plans.
b. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
c. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or 'OFF' position

2. Where specifically indicated or required by NEC

a. Adjustable [L] Long time time-delay and ampere setting with Long time pickup (ampere setting) determined by interchangeable rating plug.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.

e. Where indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
g. Trip device of circuit breakers shall be of same type for tripping coordination.

E. Fused Switch Assemblies:

1. FS W-S-865; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: FS W-F-870. Designed to reject all except Class R fuses, type as specified.
2. Switch handles shall be provided with provisions for locking handle in the 'ON' or 'OFF' position.
3. Fusible Switch Assemblies, Larger than 800 Amperes: Bolted pressure contact switches. Fuse Clips: FS W-F-870. Designed to accommodate Class L fuses.
4. Fuse Manufacturers: Bussmann, Shawmut, Brush, or approved equal.
5. Fuse Sizes: as indicated on the drawings. Provide an appropriately sized spare fuse cabinet (with nameplate and directory) with one spare set of fuses (minimum of three) for each current rating and type used on the entire project. All fuses shall be of the same manufacturer.

2.4 INSTRUMENTATION (when indicated on plans)

A. Three five ampere current transformers per breaker, including main terminated in a shorting block.

B. Three 120V potential transformers for main incoming voltage.

C. Meter: Provide a UL listed and digital multifunction power monitor. The monitor case shall be fully enclosed and shielded. The monitor shall accept a voltage monitoring range of up to 600 volts, phase to phase. The Monitor shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral; real power, reactive power, apparent power, power factor and frequency. The Monitor shall monitor max/min average demand values for all current and power readings. The demand interval shall be user programmable. The Monitor shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power functions, and shall meet IEC687 (0.2%). The monitor shall include a three line, integrated, light-emitting diode (LED) display. The display shall provide user access to all phase voltages (phase to neutral and phase to phase), currents (phase and neutral), watts, VARs, VA, power factor, frequency and kwh. The monitor shall be microprocessor based and shall be fully user programmable. The monitor shall be provided with an RS485 digital communications port. The Monitor shall communicate using a MODBUS RTU protocol and shall have a communication baud rate of at least 57k. The monitor shall be provided with one KYZ pulse outputs

2.5 OPTIONAL FEATURES

A. When indicated on drawings, provide single phasing protection with UL listed phase monitor, relays, shunt trip coils and all necessary accessories and wiring to trip designated circuit breakers (with motor loads) when voltage of any phase drops below 88 percent of rated voltage. Taylor "Phase Guard" Model PND with a two second delay.

2.6 LUGS AND HARDWARE

A. Cable connectors shall be mechanical type lugs, suitable for copper or aluminum cables. All hardware used on conductors shall have high tensile strength and a suitable protective finish. All connections shall be made with Belville washers.

2.7 PROVISIONS FOR HANDLING

A. Provide adequate lifting means.

B. Switchboard shall be capable of being rolled or moved into installation position and bolted directly to the floor without use of floor sills.

2.8 WIRING

A. Provide all necessary control and instrumentation wiring.

B. Provide fuses, fuse blocks, control transformers, terminal blocks with suitable numbering strips, relays, auxiliary contact switches on circuit breakers as required.

C. Locate terminal blocks for remote load monitoring transducers in CT compartment for future extension by Owner.

D. All low voltage and control wiring shall be physically isolated from live busses so that safe access can be obtained without de-energizing the switchboard.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install switchboard in locations shown on Drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Provide 2" high concrete leveling pad under switchboard. Dimension 6" larger than footprint of equipment. Anchor to pad with ½" anchor bolts.

3.2 FIELD QUALITY CONTROL

A. Testing: Refer to Section 260501 – Field Test and Operational Check.

3.3 IDENTIFICATION

A. Provide engraved lamacoid nameplate for the switchboard and each component.

B. Provide warning signs.

3.4 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit breaker trip ranges.

B. Adjust all operating mechanisms for free mechanical movement.

C. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262413

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch-circuit panelboards.
2. Distribution panelboards.

B. Related sections:

1. Section 260501 - Field Test and Operational Check.
2. Section 260526 - Grounding.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of panelboards and overcurrent protective devices.
d. UL listing for series rating of installed devices.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Maintenance Data: For panelboards and components, include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

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

B. Comply with NEMA PB 1.

C. Comply with the NEC.

1.5 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Panelboards, Overcurrent Protective Devices and Accessories:

a. Eaton Corp.; Cutler-Hammer Products.
b. General Electric Co.; Electrical Distribution & Control Div.
c. Siemens
d. Square D Co.; Schneider Electric Brands
e. Or approved equal.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush or surface mounted cabinets (as indicated on drawings). Construct cabinets with code gauge galvanized steel. Provide minimum 20" wide cabinets and extra wiring space where incoming feed-through or parallel lines are shown. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X.

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Doors: Provide door-in-door construction, made of cold-rolled steel. Inner door shall provide access to breaker handles and outer door shall provide access to wiring space as well. Inner door shall be completely flush with no visible bolts, screw-heads or hinges and with flush catch and lock. Outer door shall have concealed hinges, flush catch and lock to match inner door, located in line with inner door catch. (Tee bar handles are not acceptable).

D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity. Attach circuit breakers to bus so that circuits 1, 3, and 5; 2, 4, and 6, or any three similarly numbered circuits form one three-phase, four-wire circuit.

G. Main and Neutral Lugs: Compression or mechanical type suitable for use with conductor material.

H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

J. Isolated Equipment Ground Bus: Where indicated on drawings - Adequate for branch-circuit equipment ground conductors; insulated from box.

K. Extra-Capacity Neutral Bus: Where indicated on drawings, neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Where indicated on plans, On 120/208Y Panels fed by K factor Type Transformer.

L. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor. Where indicated on plans.

M. Gutter Barrier: Arrange to isolate individual panel sections.

N. Feed-through Lugs: Compression or mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device. For two-section panels.

O. Panels located adjacent to each other shall have identically sized enclosures and trims.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating. If not series rated: Fully rated to interrupt symmetrical short-circuit current available at terminals or the rating indicated on the plans, whichever is higher.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices:

1. 120/208Y volt branch circuit panelboards: Quick-make, quick-break, molded case plug-in type designed for 120/208Y volt, three-phase, four-wire service with minimum 10,000 amperes rms short circuit rating.
2. 277/480Y volt branch circuit panelboards: Molded case bolt-on type designed for 277/480Y volt, three-phase, four-wire service with minimum 14,000 amperes rms short circuit rating.
3. Provide multi-pole units with common trip elements.
4. Breaker shall have center-tripped position in addition to the ON and OFF positions.
5. Provide lockouts for all circuits that should not be inadvertently tripped (as indicated on the drawings).

2.5 DISTRIBUTION PANELBOARDS

A. Dead-front, dead-rear, Nema 1 or 3R enclosure as indicated, designed for use on a three-phase, four-wire, 120/208Y or 277/480Y volt system. See drawings for additional details.

B. Construction: Code gauge galvanized steel fully flanged for strength and rigidity. Door and trim shall be cold-rolled steel, code gauge. Provide concealed butt hinges and 3-point catch and lock. Provide separately hinged or bolted vertical access doors over lug and wiring spaces.

C. Bus Bars: Panel shall be fully bussed. Shall be used throughout and shall be hard-rolled, electrolytic copper of 98% conductivity designed for a maximum 1000 amperes per square inch. Bars shall be factory pre-drilled to accept future field

installation of 2 or 3 pole circuit breakers in any combination. Brace all bus bars for required short circuit rating of the panel, but in no case less than 35,000 amperes rms, Refer to Short Circuit information above for additional requirements.

D. Main Overcurrent Protective Devices: Circuit breaker unless otherwise noted.

E. Provide handle locking devices for all circuit breakers.

F. Provide engraved nameplates with minimum ¼" high letters secured to panel front and for each circuit protective device in panel.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Main Breaker (or Feeder) Assemblies rated for 1200 Amps:

1. Main (or feeder) breakers rated for 1200 Amp may be Molded Case with temperature insensitive, solid-state trips, current sensors and solid-state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit breakers shall have the following features:

   a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
   b. Adjustable [L] Long time time-delay and ampere setting.
   c. Adjustable [S] Short time-delay and pick-up.
   d. Adjustable [I] Instantaneous trip.
   e. For 277/480Y systems rated 1000 Amp or higher - Adjustable [G] Ground fault pick-up and delay is required.
   f. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
   g. Adjustable [R] Reduced Entergy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
   h. Where indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
   i. Short circuit, overload and ground fault trip indicators.

B. Feeder Circuit Breaker Assemblies 400 Amps or larger:

1. Feeder Circuit breakers 400 Amps or larger shall be digital solid state true RMS sensing Molded Case Circuit Breakers with temperature insensitive, solid-state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit Breakers shall have the following minimum features:

   a. UL listed for 80 percent load application unless otherwise indicated on plans.
   b. Long time pickup (ampere setting) determined by interchangeable rating plug .
   c. Adjustable instantaneous with short time tracking function.
   d. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
   e. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or 'OFF' position

2. Where specifically indicated or required by NEC

   a. Adjustable [L] Long time time-delay and ampere setting.
   b. Adjustable [S] Short time-delay and pick-up.

c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
e. Where indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
g. Trip device of circuit breakers shall be of same type for tripping coordination.

C. Feeder Circuit Breaker Assemblies 150 Amp and below:

1. Feeder Circuit breakers 150 Amp and below shall be thermal Magnetic Circuit breaker: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits, unless otherwise indicated or required to meet Section 2.4 C above. Minimum features below:

a. UL listed for 80 percent load application unless otherwise indicated on plans.
b. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
c. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or 'OFF' position

2. Where specifically indicated or required by NEC

a. Adjustable [L] Long time time-delay and ampere setting with Long time pickup (ampere setting) determined by interchangeable rating plug.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
e. Where indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
g. Trip device of circuit breakers shall be of same type for tripping coordination.

D. General Breaker Requirements:

1. Minimum interrupting capacity shall match the minimum required interrupt rating of the panel.
2. Standard frame sizes, trip ratings, and number of poles.
3. Lugs: Mechanical or compression style, suitable for number, size, trip ratings, and material of conductors.
4. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
6. Shunt Trip: 120-V trip coil energized from separate circuit.

PART 3 -EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Clearances: Minimum code required clearances around panelboards must be maintained.

C. Mounting Heights: Top of trim 78 inches above finished floor, unless otherwise indicated.

D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Mounting Hardware: Provide all necessary blocking, channels and other hardware for securing panelboards to wall, column or other parts of building structure.

F. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

G. Install filler plates in unused spaces.

H. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall include panel designation, voltage and phase in minimum ¼" high letters.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.4 FIELD QUALITY CONTROL

A. Testing: Refer to Section 260501 – Field Test and Operational Check.

B. After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balancing Loads: After Substantial Completion, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.

B. Adjust all operating mechanisms for free mechanical movement.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes receptacles, switches, and finish plates.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

1.4 SUBMITTALS

A. Submit shop drawings and product data.

1.5 COORDINATION

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

B. Wiring Devices:

1. Bryant; Hubbell, Inc.
2. GE Company; GE Wiring Devices.
3. Hubbell Wiring Device – Kellems
4. Leviton Manufacturing Co., Inc.
5. Pass & Seymour/Legrand; Wiring Devices Div.
6. Cooper Wiring Devices
7. Or approved equal.

C. Multi-outlet Assemblies:

1. Wiremold.
2. Hubbell, Inc.; Wiring Devices Div.
3. Or approved equal.

2.2 RECEPTACLES

A. General Requirements for All Devices

1. Each device shall have an amperage rating not less than that of the branch circuit(s) overcurrent protection device. White color, unless noted otherwise.
   a. Emergency devices backed up by an emergency generator and the associated cover plates shall be Red color.
2. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. All devices shall be Commercial Specification Grade (Construction specification grade is prohibited), unless noted otherwise.
   a. All convenience receptacles shall be Heavy-Duty 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 5362 Series or similar.

B. Straight-Blade: All devices shall be Tamper Resistant where required by the National Electric Code and/or local amendments.

1. Tamper Resistant—Convenience Receptacles: 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362xxTR Series or similar.

C. GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter. Provide one device for each location, daisy-chaining devices to achieve GFCI protection is not approved for this project.

1. Duplex GFCI Convenience Receptacles, 125 V, 20 A.
2. Straight Blade, non-feed through type.
3. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
4. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
5. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; GFRST20xx Series or similar.

E. Mulit-Outlet assemblies: Metal with White color finish, unless noted otherwise.

1. Two-piece surface (painted steel, brushed aluminum) raceway, with factory-wired multi-outlet harness.
2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
3. Receptacles: 20 A, 125-V, NEMA WD 6 Configuration 5-20R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
4. Receptacle Spacing: 6 inches
5. Wiring: No. 12 AWG solid, Type THHN copper, single circuit.

2.3 SWITCHES

A. Snap Switches: General-duty, quiet type, rated 20 amperes, 120/277 volts AC. Handle: white plastic, unless noted otherwise.

1. TOGGLE SWITCHES: Heavy-duty, quiet type, rated 20 amperes, 120/277 volts AC Comply with NEMA WD 1, UL 20, and FS W-S-896.
   a. Single Pole: Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 1221 Series or similar.
   b. Double Pole: Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 1222 Series or similar.

c. Three Way: Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 1223 Series or similar.
d. Four Way: Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 1224 Series or similar.

2. Pilot-Light Switches, Single pole, with neon-lighted handle, illuminated when switch is “on”, 20 A, for 120 and 277 V. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL1221PL Series or similar.
3. Illuminated Switches, Single pole, with neon-lighted handle, illuminated when switch is "off." 20 A, for 120 and 277 V. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL1221IL Series or similar.
4. Key-Operated Switches, 120/277 V, 20 Amp, with factory-supplied key in lieu of switch handle. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL1221L Series or similar.

B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible and electromagnetic noise filters

1. Control: Continuously adjustable slide. Single-pole or three-way switch to suit connections.

2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable slide; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch wire connecting leads.

3. Fluorescent Lamp Dimmers: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming to a maximum of 1 percent of full brightness.

2.4 WALL PLATES

A. Single and combination types match corresponding wiring devices.

1. Cover plate: Stainless Steel, unless noted otherwise.
2. Cover plate for surface mounted devices: Galvanized steel.
3. Weatherproof cover plate: While in use, gasketed, cast metal, hinged device covers.
4. Plate-Securing Screws: Metal with head color to match plate finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, vertically, with height as indicated or six inches above counters.

F. Group adjacent switches under single, multi-gang wall plates.

G. Protect devices and assemblies during painting.

H. Install wall switches with off position down.

I. Install cover plates on switch, receptacle, and blank outlets.

3.2 IDENTIFICATION

A. Switches and receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on the outside of the face plate for receptacles and on the inside of the face plate for switches; utilize durable wire markers or tags within all outlet boxes. Labels shall be Brother ½" TZ tape, black ink on clear, extra-strength adhesive tape, with size 18 text or engineer approved equal. Use matching label printer.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.4 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Check each device to verify operation.

B. Test GFCI operation according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, starters, and motor control centers; and spare fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

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

C. Comply with NEMA FU 1.

D. Comply with the NEC.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Furnish one set of three of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Cooper Industries, Inc.; Bussmann Div.
2. Gould Shawmut.
3. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
4. Or approved equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare fuse cabinet.

3.3 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

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SECTION 262815 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

A. Provide and install motor disconnects.

B. Provide and install circuit disconnects.

1.3 REFERENCES

A. Underwriters' Laboratory, Inc. - Annual Product Directories.

B. NEMA - Classification of Standard Types of Nonventilated Enclosures for Electric Controllers.

1.4 REGULATORY REQUIREMENTS

A. Conform to National Electrical Code and to applicable inspection authority.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cutler-Hammer/Westinghouse, General Electric, Siemens, Square D, or approved equal.

2.2 COMPONENTS

A. Motor and circuit disconnects shall have an Underwriters' Laboratory label.

B. Single Phase 120 Volt Disconnect Switches: Single pole toggle switch with thermal overload motor protection where indicated. A Horse Power rated switch may be used where fractional horse power motors have internal overload protection.

C. Single or Three Phase Motor Disconnect Switches: two or three pole heavy duty or fusible where other loads are on same circuit, 250 or 600 volt as required in NEMA Type 1, 3R, or 4 enclosures designed to reject all except Class 'R' fuses.

2.3 ACCEPTABLE MANUFACTURERS - FUSES

A. Cooper Bussmann, Edison, Littelfuse, Ferraz Shawmut, or approved equal.

2.4 FUSES

A. As indicated on the drawings. All shall be of the same manufacturer. Provide one spare set of fuses (minimum of three) for each current rating and type used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motor and circuit disconnect as indicated on Drawings and as required by Code. Where fuses are indicated, provide fuses correlated with full load current of motors provided.

END OF SECTION 262815

SECTION 264314 - TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

A. Transient Voltage Surge Suppression (TVSS) or Surge Protective Device (SPD) suitable for protection of electronic equipment and electrical systems 600 volts or less.

B. Definition: The term Transient Voltage Surge Suppression (TVSS) describes the equipment called a Surge Protective Device (SPD) necessary for the protection of all AC electrical circuits and equipment from the affects of lightning induced voltages, external switching transients, and internally generated switching transients resulting from inductive and/or capacitive load switching.

1.3 REFERENCES

A. Underwriters Laboratories, Inc. (UL) No. 1449 Rev. 2 Standard for Fire and Safety-TVSS

B. Institute of Electrical and Electronics Engineers (IEEE) Std. 142-Recommended Practice for Grounding and Std. 518-Recommended Guide on Electrical Noise ANSI/IEEE C62.41-1991 Edition.

C. Federal Information Processing Standards Publication 94 (FIPS PUB 94).

1.4 SUBMITTALS

A. Submit product data under provisions of Division 1.

B. Manufacturers' Product Data: Submit material specifications and installation data for products specified under Part 2.

C. Performance Specification: The specification shall provide the minimum information as listed below.

1. Electrical characteristics and ratings for each type of SPD.
2. Drawings shall be provided indicating SPD's dimensions, weights, mounting provisions, and connection details to the power system.
3. Provide documentation of the SPD's UL 1449 listing. Any submittal without this documentation will be rejected.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Current Technology, Cutler Hammer/Westinghouse, General Electric, Southern Tier Technologies, Siemens, Square D or Tycor International.

B. Substitutions: Under provisions of Division 1.

2.2 GENERAL

A. The TVSS System as required, shall consist of a Service Protection Panel for each service rated 600 volts or less, and Branch Panel Protectors as indicated on the drawings.

B. All devices shall operate as a total coordinated and engineered system, as well as being engineered as a system by the manufacturer.

C. Maximum continuous operating voltages of any system component shall not be less than 115 percent of the nominal system operating voltage.

D. All TVSS components shall be rated with an operating temperature range of 30 to 120 degrees Fahrenheit, and from 0 to 85 percent humidity noncondensing.

E. TVSS components shall operate in altitudes up to 20,000 feet above sea level.

F. No system component shall generate appreciable magnetic fields or sufficient fields to damage stored magnetic data.

G. Average power consumption of any single TVSS system shall be 1 watt per phase or less with zero percent total harmonic distortion.

H. Nominal system frequency is 60 Hertz; operating frequency range of the TVSS system shall be 0 to 400 Hertz.

I. All SPD's shall be connected in parallel with the power system they are protecting. Series connected components shall not be used. Suppression paths shall not be ground.

J. All SPD's shall be UL 1449 Rev 2 listed and bear the UL label.

K. All SPD's shall be equipped with integral in line fusing.

L. All SPD’s shall bolt directly to the panelboard bussing or utilize a specialized cable designed to minimize voltage let-thru in the event of a surge.

2.3 MAIN SERVICE SPD

A. The Main Service SPD enclosure shall be NEMA '1' construction, factory primed and painted.

B. The Main Service SPD shall be installed parallel via a circuit breaker or fused switch rated for the interrupting current of the Main Switchboard or Panel, or the unit shall have 200K AIC internal fuses for direct bus bar mount.

C. During normal suppression operation, the unit shall not short circuit or crowbar the power flow that would result in an interruption to the load.

D. Unit shall not require interruption of building power for maintenance.

E. Provide visual indication on the cover of the enclosure to indicate proper systems operation.

F. Surge Current Capacity: Total surge current per phase (based on an 8 x 20 microsecond waveform) that the device is capable of surviving shall not be less than 250 kA per phase, or 125 kA per mode on L-G, L-N and N-G (WYE system); L-L and L-G (Delta system).

G. The Main Service SPD shall be UL 1449 Rev 2 listed for Permanently Connected Products. The surge voltage rating (SVR) per UL 1449 Rev 2 shall be as follows for each service voltage:

Voltage Configuration	UL (SVR) Level
120 Volts, Single Phase	400 Vpk (L-N)
240/120 Volt, Single Phase	400 Vpk (L-N)
208Y/120 Volt, Three Phase	400 Vpk (L-N)
240 Volt, Single Phase	500 Vpk (L-L)
240 Volt, Three Phase, Delta	600 Vpk (L-L)
480Y/277 Volt, Three Phase	800 Vpk (L-N)
480 Volt, Three Phase, Delta	1000 Vpk (L-L)

H. ANSI/IEEE Category C3 Let Through Voltage: The let through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Modes	208Y/120	480Y/277
L-N	500V	900V

I. ANSI/IEEE Category B3 Let Through Voltage: Let through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Category B3 ringwave (6 kV, 500 amps) shall be less than:

Modes	208Y/120	480Y/277
L-N	130V	200V

J. Withstand: Each unit must be capable of surviving more than 3000 ANSI/IEEE C62.41 Category C transients without failure or degradation of UL 1449 Rev 2 SVR.

K. The voltage protection level (clamping voltage) shall be provided for a 10x1000 microsecond waveform per ANSI/IEEE C62.41-1991 for B3 location categories using IEEE C62.45-1987 testing techniques (power applied). The voltage protection level (clamping voltage) shall not exceed the SVR rating provided in paragraph 2.3 G. above.

L. The Service Panel TVSS shall be furnished with terminal connections capable of accepting up to #1/0 conductors.

M. The transient suppression capability shall be equal bi-directionally and shall treat both the positive and negative impulses with separate suppressor modules per phase.

N. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283.

O. Suppression shall be line to neutral, line to ground, and neutral to ground with the exception of a delta configuration which is line to line.

2.4 BRANCH PANEL SPD

A. Where Branch Panel SPD's are installed in conjunction with a Main Service SPD, it shall operate as a totally coordinated engineered system. It shall achieve performance equal to or better than the UL 1449 Rev 2 rating of the source point unit.

B. The Branch Panel SPD shall be listed to UL 1449 Rev 2.

C. The suppression path shall not be ground.

D. The unit shall not short circuit or crowbar the power flow that would result in an interruption to the load.

E. Scheduled parts replacement or preventative maintenance shall not be required.

F. The modules shall be bi-polar and bi-directional treating negative transients identically to positive transients with separate positive and negative suppression modules.

G. The Branch Panel SPD enclosure shall be NEMA '1' construction, and be factory primed and painted.

H. The SPD's shall be furnished with power on indication status (one per phase).

I. Surge Current Capacity: Total surge current per phase (based on an 8 x 20 microsecond waveform) that the device is capable of surviving shall not be less than 120 kA per phase, or 60 kA per mode on L-G, L-N and N-G (Wye system); L-L and L-G (Delta system).

J. The Branch Panel SPD shall be UL 1449 Rev 2 listed for Permanently Connected Products. The surge voltage rating (SVR) per UL 1449 shall be as follows for each service voltage:

Voltage Configuration	UL (SVR) Level
120 Volts, Single Phase	400 Vpk (L-N)
240/120 Volt, Single Phase	400 Vpk (L-N)
208Y/120 Volt, Three Phase	400 Vpk (L-N)
240 Volt, Single Phase	500 Vpk (L-L)
240 Volt, Three Phase, Delta	600 Vpk (L-L)
480Y/277 Volt, Three Phase	800 Vpk (L-N)
480 Volt, Three Phase, Delta	1000 Vpk (L-L)

K. ANSI/IEEE Category C3 Let Through Voltage: The let through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Modes	208Y/120	480Y/277
L-N	500V	900V

L. ANSI/IEEE Category B3 Let Through Voltage: Let through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Category B3 ringwave (6 kV, 500 amps) shall be less than:

Modes	208Y/120	480Y/277
L-N	130V	200V

M. Lifecycle: Each unit must be capable of surviving more than 2500 Category C transients without failure or degradation of UL 1449 clamp voltage.

N. The Branch Panel SPD shall be integral with the panelboard and bolt directly to the panelboard bussing or utilize a specialized cable designed to minimize voltage let thru in the event of a surge.

O. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283.

PART 3 - EXECUTION

3.1 WARRANTY

A. Warranty: The equipment shall be warranted against defects in material and/or workmanship for a minimum of five years.

3.2 INSTALLATION

A. The installation shall comply with the manufacturers' printed instructions, and any national and local wiring codes.

3.3 IDENTIFICATION

A. Refer to Electrical Identification, Section 16195, for identification requirements.

3.4 FIELD QUALITY CONTROL

A. The TVSS System shall be installed in accordance with the manufacturers' printed instructions to maintain warranty.

B. Upon completion of installation, the TVSS System shall not require testing of any kind.

END OF SECTION 264314

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SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces and recessed in canopies, emergency lighting units, and accessories.

B. Related Sections include the following:

1. Section 260923 Lighting Control Devices.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features and accessories.

B. Maintenance data for lighting fixtures.

C. Emergency lighting units including battery and charger.

1.4 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with the NEC.

C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, partition assemblies, and other construction.

1.6 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: As indicated on the drawings.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit maintenance without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during maintenance and when secured in operating position.

D. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
2. Lens Thickness: 0.125 inch minimum, unless greater thickness is indicated.

2.3 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs: As follows:

1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Remote Test – Where indicated on the drawings: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers

simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

7. Integral Self-Test – Where indicated on the drawings: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.4 EMERGENCY LIGHTING UNITS

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate fixture continuously at an output of 1100 lumens for 90 minutes. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space. Provide integral to fixture or mounted adjacent to fixture.
    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.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
5. Battery: Sealed, maintenance-free, nickel-cadmium type.
6. Charger: Fully automatic, solid-state type with sealed transfer relay.
7. Night-Light Connection: Where night-light option is called out in the drawings, operate the fixture continuously.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering the light fixture, remote mounted from the lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate fixture continuously at an output of 1100 lumens for 90 minutes. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Battery: Sealed, maintenance-free, nickel-cadmium type.
3. Charger: Fully automatic, solid-state, constant-current type.
4. Housing: NEMA 250, Type 1 enclosure.
5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.5 FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

C. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

F. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

2.9 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials.

B. Furnish and install a protective barrier around fixtures that are not insulation-contact-rated (non-IC-rated) in locations where insulation is installed. The protective barrier shall be installed to yield a 4" air-gap from the fixture on all sides and top.

C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Attach supports to building structure.

1. Light fixtures (all types) shall be mechanically attached to grid per NEC 410-16 (two per fixture unless independently supported).
   a. Surface-mounted fixtures shall be attached to grid.
   b. Pendant-hung fixtures shall be directly supported from structure with 9-gauge wire (or approved alternative).
   c. Rigid lay-in or can light fixtures:
      i. <10 lbs. - one wire to structure (may be slack)
      ii. 11 to 56 lbs. - two wires from housing to structure (may be slack).
      iii. >57 lbs. - supported directly to structure by approved method.

D. Suspended Fixture Support: As follows:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings.

3.2 CONNECTIONS

A. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests: As follows:

1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.4 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 265100

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SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.

B. Related Sections include the following:

1. Section 260923 - Lighting Control Devices.
2. Section 265100 - Interior Lighting for interior fixtures, lamps, emergency lighting units, and accessories; and for exterior luminaires normally mounted on buildings.

1.3 DEFINITIONS

A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.

B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.4 SUBMITTALS

A. Product Data: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories and finishes.

B. Maintenance data for lighting units.

1.5 QUALITY ASSURANCE

A. Luminaires and Accessories: Listed and labeled as defined in the NEC, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction.

B. Comply with ANSI C2.

C. Comply with the NEC.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: As indicated on the drawings.

2.2 LUMINAIRES

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

D. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.

E. Exposed Hardware Material: Stainless steel.

F. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

G. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

H. Verify availability of space to install device at or close to ballast. Unit as specified is suitable for full 15-a branch-circuit protection. Coordinate with Drawings.

I. Lamps: Comply with the standard of the ANSI C78 series that is applicable to each type of lamp. Provide luminaires with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a luminaire, provide medium wattage lamp recommended by manufacturer for luminaire.

1. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.

2.3 LUMINAIRE SUPPORT COMPONENTS

A. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 80 mph with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

C. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Will not cause galvanic action at contact points.
2. Mountings: Correctly position luminaire to provide indicated light distribution.
3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
4. Anchor-Bolt Template: Steel.

E. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.

F. Steel Poles: Tubing complying with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in length with access handhole in pole wall.

G. Steel Mast Arms: Fabricated from NPS 2 black steel pipe, continuously welded to pole attachment plate with span and rise as indicated.

H. Metal Pole Brackets: Match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate luminaire.

I. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

J. Concrete for Pole Foundations: Comply with Division 3.

2.4 FINISHES

A. Steel: Grind welds and polish surfaces to a smooth, even finish.

1. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123.
2. Surface Preparation: Clean surfaces to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel.
3. Interior: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
4. Polyurethane Enamel: 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 the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Concrete Foundations: Construct according to Division 3.

B. Install poles as follows:

1. Use web fabric slings (not chain or cable) to raise and set poles.
2. Mount pole to foundation with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
3. Secure poles level, plumb, and square.

4. Grout void between pole base and foundation. Use non-shrinking or expanding concrete grout firmly packed in entire void space.
5. 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.

C. Luminaire Attachment: Fasten to indicated structural supports.

D. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 CONNECTIONS

A. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

B. Ground metal poles/support structures.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units.

3.4 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

END OF SECTION 265600

SECTION 271101 – TELECOM RACEWAY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes telecom raceway systems.

1.3 RELATED WORK

A. Section 260533 – Raceways and Boxes.

B. Section 260536 – Cable Trays.

1.4 SYSTEM DESCRIPTION

A. Conduit, cable trays and boxes to form an empty raceway system.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Conduit: Refer to Section 260533.

B. Cable trays: Refer to Section 260536.

C. Outlet, pull or junction boxes: Refer to Section 260533.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide pullboxes in telecom conduit runs spaced less than 100 feet apart, and on the backboard side of runs with more than two right angle bends.

B. Place telecom label on pull and junction boxes.

C. Provide pullwire in each telecom conduit run.

END OF SECTION 271101

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SECTION 275116 - INTEGRATED COMMUNICATIONS AND CLOCK NETWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The drawings and general provisions of the Contract Documents apply to this Section.

1.2 SUMMARY

A. This section includes a fully operational IP platform for a district-wide internal and school Critical Communications Solution, incorporating school safety notifications and general communications including but not limited to the following:

1. The platform shall provide complete internal communications and employ state of the art IP Technology including the minimum functions listed.
    1) Two-way internal intercommunications between staff locations and classrooms.
    2) Scheduled bell events.
    3) Emergency announcements that will override any pre-programmed audio, assuring that all Emergency/Lockdown etc., are heard at each speaker location.
    4) Capability of prerecording emergency announcements that can be activated by a Soft Key on an administrative console, panic button, dial string, mobile app, or web browser.
    5) Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone.
    6) District-wide, Emergency, Group, All School and Zone live voice paging.
    7) District-wide, Emergency, group, All School and Zone visual messaging.
    8) District-wide, Emergency, Group, All School and Zone paging for pre-recorded audio – tones, music and voice.
    9) Single sign on web-based user interface for multi-school functionality.
2. The system shall support a minimum of 1000 level priorities which shall be user-definable, allowing each end point to place a minimum of 5 different priority calls at the same time.
3. Any authorized administrator shall be able to call from outside the school into any classroom, zone, or entire school directly via the School District supplied SIP enabled Telephone Network. This shall allow remote monitoring, call-in annunciation, and two-way conversation from outside the facility as well as paging into the system. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools).
4. Authorized system users shall be able to create a minimum of 100 automated sequences with voice instructions, tones, emails, program distribution, and relay activations and replay them.
5. Automated message strings shall be manually initiated from a single-button access on the console, on a SIP connected telephone, panic button, mobile app, from the web-based user interface or via interface with third party systems.
6. Paging and two-way intercom features shall be accessible from any system console or SIP connected telephone for each campus.
7. The platform shall synchronize its system time to the network timeserver or a web-based time server.
8. Each single campus installation shall be locally survivable for intercom, paging, bells, and emergencies such as lockdown, even when the district connection is unavailable.
9. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system.
10. Systems that do not comply with the feature-sets highlighted in this Specification will not be considered.

11. Included in the emergency procedures is the ability to send specific messages and or instructions. These features can be added to the emergency sequences.
12. The ability to require an access code to initiate or clear an emergency from the administrative console.
13. An app that can run on either Android or Apple phones. This app will give the user the ability to initiate one of 18 emergency procedures programmed into the app. This app will also allow you to view all classrooms check in status. This process will update during the emergency to make sure all information is current.
14. The ability to allow the fire alarm system to signal an active fire alarm to TCU. This will allow supplemental visual and audio messaging from Telecenter U. Telecenter U can be programmed to change system state, dependent on the active emergency. Both fire and emergency will be displayed on the administrative console and mobile application.
15. Any system that requires more then one Cat drop to a classroom to control an IP speaker, up to 5 call-in switches, status lights (up to 2) and message board/digital clock will not be considered equal to the specified system.

1.3 DEFINITION OF TERMS

A. Installer(s): Shall refer to the person, persons, or company who or which contracts to perform the work specified herein.

1.4 SUBMITTALS

A. Product data for each component.

B. Shop Drawings: Prior to proceeding with the work: Provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, location of each field connection, and a complete schedule of all equipment and materials with associated manufacturer's cuts sheets which are to be used.

1) Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.
2) Artwork drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.
3) Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor's name in the title block.
4) Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

D. Maintenance Data: For equipment to be included in maintenance manuals specified in Division 1.

1) Record of Owners equipment-programming option decisions.
2) All instructions necessary for proper operation and manufacturer's instructions.

3) "Proof of Performance" information.
4) Manufacturer's maintenance information.
5) Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.

E. Record Drawings: Prior to final acceptance, provide three (3) complete sets of drawings indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions. These Record Drawings will be used during "Final Acceptance Testing".

F. System Training: Submit the following information describing the training programs and system trainers as outlined in paragraph 1.6 of this specification and in accordance with Division 1 specifications.

1) Include with the submittal a preliminary staff development training program in outline form for review and approval by the owner's representative.
2) Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the project.
3) Include with the submittal a current copy of trainer's needs assessment form which will be reviewed with the owner's designated representative for the system's preliminary system programming and configuration.
4) Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.

G. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced Installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following within thirty (30) days after notification to proceed:

1. Provide a list of installations that the Installer has specifically installed for verification by the Owner. Random installations from other vendors and/or Installers shall not be accepted. The Installer, not its employees, must meet these qualifications.
2. The Installer shall be bondable.
3. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:
   1) Adequate plant and equipment to pursue the work properly and expeditiously.
   2) Adequate staff and technical experience to implement the work.
   3) Suitable financial status to meet the obligations of the work.
   4) Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.

B. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of an "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer.

C. Because the life expectancy of this type of communications structure normally exceeds 10 years, the owner expects continuity from the service provider. If the installing/servicing company has not been an authorized provider of the manufacturer's product for it least (10) years, the following is required:

1. A list of (2) systems manufacturers of which they currently are authorized service providers where the relationship exceeds (10) years.
2. A letter from the manufacturer outlining the details of changes in service providers over the last (10) years and what actions they will take to ensure continuity of service to the customer.

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

E. Comply with NFPA 70

F. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.

G. Comply with UL 60950.

1.6 IN-SERVICE TRAINING

A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.

B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.

C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all the staff and faculty members who attended, received, and completed the training program.

1.7 WARRANTY

A. Provide a manufacturer's five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic system components. Additional warranties cover clocks, speakers, and call-in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one-year warranty shall be provided for labor.

B. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.

C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.

D. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

1.8 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide the following system:

1. Telecenter manufactured by Rauland
   1) Authorized Rauland Distributor contact:
      Marshall Industries
      1303 N 39th Street
      Nampa, ID 83687
      Jeremy Waddell
      Jeremy.waddell@marshallind.com

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. The platform shall utilize state of the art IP Technology for Emergency automation, Call-in Notification, School Safety Paging and Evacuation tones, Class Change Tones utilizing multiple, programmable schedules for each zone, two-way hands-free everyday internal communications and paging, visual messaging, and program distribution. The system shall be easy to learn and operate. All standard programming shall be web-based, district-wide and user friendly to allow the system administrator the ability to easily program system features.

B. Provide complete and satisfactorily operating district/school communications and district/school safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

C. The platform shall be a single electronic system consisting of a minimum of 10 audio channels for each campus, (classroom) IP Speaker Modules and call switches, IP Zone Modules connecting corridor speakers, inside and outside horns, IP Administrative Consoles, SIP enabled PBX integration and district-wide integration for paging, emergency notifications, calendar scheduling and configuration.

D. Each Classroom shall be provided with a Speaker Module interface, a status light, and a minimum of 5 different call switches, each with their own annunciation path and priority.

E. Call-ins may automatically annunciate (display of priority and location) to administrative consoles, SIP enabled phones, and outside phones.

F. Call-ins shall be programmed to automatically change priority and annunciation route based on age of call-in and original priority.

G. Call-ins may have priority (and annunciation route) changed by user action from a console or SIP enabled phone.

H. Call-in annunciation route shall include playing pre-recorded audio over speakers, sending a pre-configured email, and activating relays.

I. The platform shall lend itself to expansion by simple addition of hardware modules.

J. The platform shall connect directly to an existing, standard protocol WAN/LAN network, without the need for a separate server at each school location. Configuration, including bell schedules, calendars, and emergency

sequences can be remotely created, changed, stored and downloaded to the system by an authorized user from a web-based user interface.

K. The platform shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone or connected web browser within the facility or outside the facility to any other location within the facility or district.

L. The platform shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within the facility or outside the facility to any other location within the facility; all communication within the classroom shall be hands-free and will not require any interaction by the classroom user.

M. The platform shall provide classroom users the ability to confirm that they have safely secured their classrooms during an emergency with a single button press. The front office administrator will receive confirmation that the classroom is safely secured via an administrative console and web-based user interface. The front office administrator can view classrooms that are not safely secured via the administrative console. The front office administrator can view classrooms that are not safely secured via the web-based user interface. The front office administrator shall be able to initiate two-way communication, without a pre-announcement tone, to the classroom during an emergency via the administrative console. Web-based user interface will still identify that a school is in an emergency, even if all classrooms are safely secured. Individual classroom check-in and school emergency status shall be viewed from the web-based user interface, both on-site and remotely.

N. IP Addressable and POE powered Speaker Modules for individual rooms shall be system programmable and may be assigned any two, three, four, five- or six-digit number as well as name and description. Any extension may be reassigned at any time.

O. IP-enabled two-way voice communication shall be available from any provided telephone or administrative console through any speaker in a campus. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active, complying fully with all privacy legislation. Pre-announce tone and supervisory tones shall be disabled during designated emergencies automatically.

P. The platform shall allow users to configure multiple schedules per school, with a minimum of 500 unique events per schedule, and automatic Daylight Savings time correction. Schedules can be programmed to occur once, daily, weekly, monthly, or in any combination of the preceding recurrences. Each school may have a minimum of 20 unique bell schedules, with a minimum of 5 active schedules on any given day for each campus. User shall be able to select from 25 standard included tones as well additional user created and uploaded audio files for class change signaling and messaging. In addition, scheduled events shall include relay actions, email notifications, visual messaging, status lights and paging exclusions as system configuration changes. The platform shall allow control of the bell schedules via the district WAN/LAN without the need for a separate server at each school location. Bell schedules can be remotely created, changed, stored and assigned to calendar days for the local school by an authorized user from a single web-based user interface, without logging into multiple systems.

Q. The platform shall be able to integrate with an existing PA system or operate as a fully independent IP solution. The platform shall be able to function in combination of said configurations and allow for seamless communication within a school or district-wide, regardless of the type of configuration used. The platform shall be scalable, with the ability to easily add, install, and configure additional equipment to a system.

R. The platform allows for customization of preprogrammed sequences, used for emergencies, events, and everyday communications. Preprogrammed sequences can be activated from the push of a relay button, soft key of an administrative console, a dial string of a SIP phone, or a web browser configured to the district network. Sequences can be initiated automatically as part of a schedule or on the fly. Preprogrammed sequences can be customized to utilize any combination of audio tones, emails, relays, tone exclusions,

swings, delays, duples, SIP phone notifications, and program distribution. Audio tones can include customized audio files and voice messages, recorded in any language. Uploaded audio tones and messages can be preprogrammed to annunciate repeatedly or individually, as part of a scheduled sequence or on the fly. Each school in the district can have its own customized sequences, and can be activated individually, in groups, or district-wide.

S. The platform allows for emergencies to be initiated in a drill environment, separate from real emergencies. Drill emergencies can be initiated from panic buttons, consoles, SIP phones, or a web browser.

T. The platform shall provide status lights that will display the status of individual classrooms and school-wide status, including for emergencies, at the same time. Status lights will be customizable in color and flash rate based on event type and priority.

U. Visual message boards are available in 2 sizes. Small message boards have 8 by 40 LED display with 3 color LED's. the large message board will have 2 lines with 16 by 80 LED display with 3 color LED's. During idle time the message boards can display date and time. They can also display countdowns for class change or status of an emergency. You will have the ability to change the messages on the fly to display instructions or directions. Status lights can be tied to message boards to give more information as to status of classrooms that checked in or groups of rooms that checked in.

V. POE zone page amplifier module. This component will give the schools the ability to play audio to drive groups of speakers from a single device. Depending upon configuration you can have 14 or 35 watts of output. The module can be either wall or rack mounted.

W. First Responders Notification. This feature can be initiated so the status lights do not display the rooms that checked in until the first responders are on site. This will not influence any of the other check-in notifications. The App, console and computers can still display the rooms that checked in.

X. TCU Emergency Initiation App. This app can be installed on either Android or Apple devises. The app can process up to 18 different emergencies. The app will update in real time rooms that have checked in OK. It can also display a Fire emergency is in effect during an emergency.

2.2 EQUIPMENT AND MATERIAL

A. Server Software

1. Provides district-wide paging, bell event scheduling, emergency notification and configuration for entire district.
2. Ability to configure system and initiate system features, per school and district-wide via web-based user interface.
3. The software can sync system time to the Atomic Clock Signal or to the school's or district's network time server.
4. The software will provide a web browser to deliver district-wide emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The software must be capable of automatically notifying district personnel via the WAN/LAN of an alarm condition.
5. The software can automatically broadcast emergency instructions via associated system hardware throughout an entire district when an alarm (e.g. lockdown, lockout, security, fire) is initiated via the web-based user interface. The emergency instructions are preprogrammed and require no user intervention. Bell tones can be halted during an emergency. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
6. The software allows for user-uploaded pre-recorded messages and tones. Software supports the upload of MP3 and WAV file types. User-uploaded pre-recorded messages and tones can be part of emergencies, sequences, and bell schedules.

7. The software can be installed in cloud, virtual or physical server environments.
8. The web-based user interface supports secure HTTP browsing.
9. The software supports encryption to ensure secure access.
10. The system shall monitor itself if devices go offline and system actions are not received. Specified users shall receive email notifications when devices go offline. The software shall be able to keep a log and report on system activity within a school or all schools district-wide for a minimum of one year. These reports can be exported to excel spreadsheets.
11. The system shall allow administrators to run reports on all system activities including emergencies, drills, paging, call-ins, check-ins and system trouble on a per school, multi-school and district-wide basis.
12. The software will support a minimum of 20 bell schedules per school, with 5 schedules assignable to a specific school day. Bell schedules can be programmed to annunciate tones, activate relays, send emails, activate program distribution, and notify SIP phones.
13. The system allows programmable end points to be automatically included or excluded for live paging, bell tones, or prerecorded audio, depending on the time or day or day of the week. These inclusions/exclusions can be applied manually or automatically depending on their schedule.
14. The software can automatically send an email, as part of a programmed sequence of events, to district administrators alerting them of an emergency within the district.
15. The software provides the ability to view schools that are in an emergency status, using any web browser on the district's network. The software shall identify the name of the school in an emergency as well the type of emergency that school is in.
16. The software provides the ability to view individual classrooms that are not checked-in during an emergency, using any web browser on the district's network. The software shall identify the name, extension, and description of the classroom that is not checked-in during the emergency.
17. The system has a minimum of 5 customizable emergencies, one of them being an All-Clear – with the ability to return the system from an emergency to normal status. Each emergency shall have a minimum of 500 unique events.
18. As a district-wide communications solution, the system shall be able to provide simultaneous communications to all schools or groups of schools within a district. The system shall allow a user to initiate district-wide communications to individual schools, all schools or groups of schools, from a web-based user interface. The system shall allow a user to initiate prerecorded audio, live paging, or programmed sequences to individual schools, all schools or groups of schools, from the web-based user interface. Programmed sequences shall be customizable per school, and the system shall be able to activate them simultaneously to individual schools, all schools or groups of schools, from the web-based user interface.
19. The communications software must allow upgrade from an individual school system to multiple schools, or an entire school district, using the same web-based user interface. The communications software from an individual school system must be identical in typical user operation to the multiple schools or entire school district communications system software.
20. The system allows for emergencies to be initiated as drills for practice. Drills may include all or some of the associated steps as its corresponding emergency sequence. Drills are recorded in the event history report.
21. The system provides the ability to export lists of bell schedule steps, emergency sequences, staff directory, users, peripherals, and zone targets.

B. Campus Controller

1. Provides call routing for paging and intercom for a single facility.
2. System shall connect to the district provided Telephone Network via a SIP connection.
3. Support a flexible numbering plan allowing two, three, four, five, or six-digit extensions.
4. SIP interface to a district provided Telephone Network shall be capable of allowing connected phones to display classroom call-ins, answer internal intercom call-ins, make pages and change priorities of call-ins in progress.

5. Direct dialing, two-way amplified voice intercom between any provided telephone or admin console and speaker without the use of a press-to-talk or talk-listen switch.
6. Ability to upgrade priority level from individual call switch.
7. The ability to answer intercom call-ins registered at administrative consoles and pre-selected telephones.
8. The ability to automatically escalate incoming call-ins to an alternate telephone or group of telephones if they remain unanswered for a predetermined amount of time.
9. The ability to manually upgrade an intercom call-in to an alternate telephone or group of telephones.
10. The ability for classrooms to "check-in" via push button when they have successfully secured their location during emergency.
11. Administrative console shall display locations that have not checked in to confirm their secured location and provide hands-free audio monitoring and communication to unsecured locations.
12. The controller shall not need direct connection to any classroom via home run or distributed wiring. It shall communicate solely through the IP network.
13. Single button access from any console on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers. Emergency announcements originating from any assigned administrative console shall have priority over all regular system functions.
14. Ability for administrative consoles and connected phones to selectively monitor audio at any two-way speaker during an emergency.
15. Stores a minimum of 48 hours' worth of Bell Event Schedules, all emergency notification sequences as well as facility wide configuration.
16. System can sync system time to the Atomic Clock Signal or to the school's or districts network time server.
17. System's SIP Interface shall provide:
    1) Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
    2) Ability to answer a call-in directed to that SIP extension.
    3) Ability to upgrade a call-in directed to that SIP extension.
    4) Single button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.
    5) Ability to initiate a school-wide emergency including lockdown and evacuate sequences.
    6) SIP device shall display call-in information from call in switch. Information will include a minimum of Classroom Name, Number, and Priority Level.
18. The system will have the ability to utilize a web browser and a USB microphone connected to the PC to deliver district-wide live emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The system must be capable of automatically notifying district personnel via the WAN of an alarm condition.
19. The system will have the ability to utilize a desktop microphone to deliver school-wide live emergency paging and zone paging throughout the facility.
20. The system can automatically broadcast emergency instructions throughout an entire campus when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. Bell tones can be halted during an emergency. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
21. The system can integrate with emergency weather radios to generate live emergency broadcasts notification throughout a facility.

C. IP Addressable Modules:

1. System shall provide multiple IP Addressable Modules for intercom, paging and relay activation.
    1) All Modules are POE 802.3af compliant
    2) All Modules support DHCP.
    3) All Modules connect to network with a single RJ45 connector
2. IP Addressable Speaker Module
    1) Shall interface to school's data network, a classroom speaker, and multiple call switches.
    2) A minimum of 5 levels of call-in can be placed from an IP Speaker Module. The call-ins are routed to administrative consoles and select SIP connected telephones and can only be cleared from the system once answered. If a call-in is not answered within a preprogrammed time the call-in may reroute to other telephones, consoles, and speakers.
    3) An option for Privacy call in switches is supported. When the Privacy switch is activated it prevents administrative or classroom telephones from monitoring the specific classroom/location intercom speaker.
    4) The ability to belong to one or more of a minimum of 100 independent zones for zone paging, program/music distribution zones and class change tone zones; this assignment is a programmable function, changeable by time of day. Each IP Speaker Module's location shall be programmed in software to belong to any combination of software zones. IP Speaker Modules shall be designed to mount near ceiling and wall speakers and in the plenum space.
    5) Intercom and paging volume adjustable from Software interface
    6) Module will support and power a status light that displays individual classroom information including call-ins placed, testing status and emergency check-in status.
3. IP Addressable Zone Paging Module
    1) Zone Paging Module shall connect multiple speakers for district all page, all page, zone paging, bells, audio events and, emergency notification.
    2) Zone Paging Modules shall be rack and wall mountable.
    3) Zone Paging Modules shall be able to belong to one or more of 100 independent zones for live paging, bells, pre-recorded audio and emergency notification.
4. IP Addressable Aux I/O Module
    1) Aux I/O Module shall have two input contacts and two output contacts.
    2) Input and output contacts are individually addressable.
    3) Aux I/O Module shall be wall and rack mountable.
    4) User can program relays to be activated manually, through an event/bell schedule, or during emergency notification.
    5) Aux I/O Module can perform school lockdown from a single press of a panic button.
5. IP Addressable Program Line Input Module
    1) Program Line Input Module shall provide line level audio program distribution into system.
    2) Program Line Input Module shall have a 3.5mm cable jack.
    3) Program Line Input Module shall be configured via web-based user interface.
    4) User can configure program distribution to be activated manually or automatically through an event/bell schedule.
    5) Program Line Input Module will have a system priority level such that emergency communications override program distribution.
6. IP Addressable Microphone Input Module
    1) The system shall support a minimum of five (5) Microphone Input Modules per school.
    2) Microphone Input Module shall support dynamic and condenser style microphones.
    3) Microphone Input Module shall support microphones with or without Push-To-Talk functionality.
    4) Microphone Input Module shall support configurable paging priorities.

5) Microphone Input Module shall provide user feedback for paging activity.
6) Microphone Input Module shall have adjustable microphone gain levels.
7) Microphone Input Module shall be configurable from the web-based user interface.
8) Live pages from the Microphone Input Module can automatically increase audio priority during an emergency.

D. IP Addressable Analog Gateway

1. IP Addressable Gateway provides integration with existing analog wiring infrastructure – consisting of shielded two-pair classroom field wiring. The Gateway provides the ability to reuse speaker wiring, speakers, and punch blocks to integrate analog infrastructure with IP platform.
2. Each Gateway will have 5 watts of power per port and 25 watts total per device.
3. Supports 24 classrooms that utilize 25 Volt speakers and all current Telecenter call switches for front office notification.
4. Supports minimum of 5 call switch priorities per classroom, capable of lockdown check-in functionality, while reusing existing shielded two-pair classroom field wiring.
5. Classroom intercom volume adjustable from Software interface.
6. Classroom paging volume adjustable from Software interface.
7. Configured to the school network and can be used in conjunction with IP Addressable Modules.

E. IP Addressable Administrative Console

1. A full color screen with 64 soft keys, 3 line select, volume control, push to talk, speakerphone mode and left/right and up/down scrolling.
2. Audio paging access from any Console to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire school.
3. Programmable soft key access from any console on the system to initiate alarm signals within the school to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative console shall have priority over all regular system functions.
4. Programmable soft key access from any console to automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
5. Ability to perform intercom to any single IP Addressable Speaker Module.
6. Ability to display 3 call-ins at a time on the screen while other call-ins are annunciating and the ability to scroll to view all call-ins.
7. Ability to upgrade a call-in via soft key.
8. Programmable soft key access from any console for activating relays, campus wide.
9. Ability to maintain, along with controller and other IP Modules system functions, including intercom, bells and paging for the local campus in the event of district-wide connection loss.
10. Classrooms that have not ‘checked-in’ during an emergency are listed on the Administrative Console’s screen.
11. The time duration of an emergency is shown on the screen of the administrative console. The check-in timer is shown on the screen of the administrative console.

F. Audio Paging/Program Amplifiers

1. Power amplifier(s) shall be provided to provide a minimum of 2 watts of power to all paging speakers, and 15 watts of power to all paging horns.
2. The maximum load on the paging/program amplifiers shall be 80% of the rated maximum output of the amplifiers.

G. Normal/Emergency Call Switch – Rauland Dual Level Call In Switch

1. Normal/Emergency Call Switches indicated on the drawings shall provide the following functions and features:

    1) One (1) “Normal” call switch that shall activate a distinctive “NORMAL” level call from single button activation. The button shall be clearly marked “NORMAL” and will route the call-in to any one or more Administrative Consoles and/or Marquee Displays for quick and easy response from an Administrative Console.
    2) One (1) “Emergency” call switch that shall activate a distinctive “EMERGENCY” level call from single button activation. The button shall be red in color and shall be clearly marked “EMERGENCY” and will route the call-in to any one or more Administrative Consoles and/or Displays for quick and easy response from an Administrative Consoles

H. Emergency/Check-In Call Switch – Rauland Check-In Call In Switch

1. Emergency/Check-In Call Switched indicated on the drawings shall provide the following functions and features:
    1) One (1) “Emergency” call switch that shall activate a distinctive “EMERGENCY” level call from single button activation. The button shall be red in color and shall be clearly marked “EMERGENCY” and will route the call-in to any one or more Administrative Consoles and/or Displays for quick and easy response from an Administrative Consoles.
    2) One (1) “CHECK-IN” call switch that shall activate a distinctive “CHECK-IN” level call from single button activation. The button shall be blue in color and shall be clearly marked “CHECK-IN” and will route the call-in to any one or more Administrative Consoles. This button will be used for emergency check-ins during school emergencies, notifying the front office of the classroom occupants’ safety during an emergency.

I. Status Light

1. Status Light will be powered and controlled by an IP Classroom Module.
2. Status lights will 2 light segments, one for classroom status and one for school status.
3. Each segment will display specific colors and blink patterns based on status priorities.
4. If you add a visual message board an additional status light can be added and driven on the 1 cat wire delivered to the classroom. Both lights can be used for different notifications inside and outside the room.

J. Zone Page Amplifier Module

1. Depending on configuration the amp output is either 14 or 35 watts output.
2. Can be wall or rack mounted.
3. Powered with either a wall wort or POE+

K. Visual message boards.

1. Can be powered by either POE or POE+ depending on size and features.
2. Comes in 2 sizes
3. Large 2 lines 16 by 80 LED display
4. Small 1 line 8 by 40 LED
5. 3 color LEDs: Red, Amber and Green

L. Equipment Racks

1. All equipment racks shall provide 44 spaces (77") minimum for mounted system equipment.
2. All equipment racks shall be multi-rack format ("gangable") style, bolted together, and open cavity.
3. All equipment racks will be provided with lockable rear doors.
4. Equipment rack(s) shall be in climate-controlled areas/rooms as shown on drawings.
5. All head-end, distribution, and source equipment, including data and power, shall be in racks configured as approved by the Engineer.
6. Rack mounted equipment shall be accessible from front and rear.
7. All unused rack spaces will be covered with appropriate blank/vent panels.

M. Interior Ceiling Speakers

1. Provide Ceiling Speaker Assembly consisting of 8 Ohm, 8" speaker mounted in a 2 foot by 2 foot, or 2 foot by 1 foot, lay-in baffle, with an integrated back box that covers the full area of the baffle.
2. The speaker shall be connected by inserting an 8-pin RJ45 terminated CAT 5e or Cat 6 cable.
3. The speaker shall include provisions to allow attachment of a safety cable if required.

N. Wall Mounted Horns

1. Provide double re-entrant type horn loudspeakers with integral driver. The horn loudspeaker shall be impervious to weather and vandalism. Horn shall be constructed of heavy-duty ABS plastic. Horn loudspeaker drivers shall be rated at 15 watts with a frequency response of 480 Hz to 14 KHz. Sensitivity shall be 106 dB 1 watt, 1 meter. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. Dispersion pattern shall be 180 degrees conical. The horn loudspeaker shall be constructed of treated heavy gauge aluminum, with all exposed parts potted and a sealed driver. Wiring terminal shall be fully enclosed. The speaker flange and mounting surface shall have a cork-rubber gasket. The horn loudspeakers finish shall be gray baked on enamel.
2. The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rust-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4"x10-3/4"x6" deep.
3. The baffle shall be vandal proof, the faceplate constructed of 14-gauge carbon steel with a minimum tensile strength of 55,000 PSI. A lattice grid sub-plate shall deny access to the horn but be acoustically transparent for sound projection. Provide tamper proof, stainless steel mounting hardware. The baffle shall a mar/scratch baked epoxy rust inhibitive finish.

O. Uninterruptible Power Supplies (UPS)

1. UPS equipment provided for this system will include Power Conditioning to smooth current and voltage fluctuations.
2. UPS equipment will be sized in accordance with the system manufacturer's recommendations.
3. Provide an individual UPS for EACH SYSTEM CONTROLLER (Gateway) furnished with the system.
4. Provide additional UPS(s) for protection of all other equipment furnished with the system and housed in the equipment racks.
5. All UPS equipment shall be rack mounted.

P. Equipment List

1	Rauland	TCU3000SW	Tcu License - Controller
AR	Rauland	TCC3022PS	Tcu Zone Page Amp Power Supply
AR	Rauland	TCC3022	Tcu Zone Page Amplifier Module

OFP	Rauland	TCC3012L	Tcu Large Message Board
OFP	Rauland	TCC3011S	Tcu Small Message Board
OFP	Rauland	TCC2211PB	Call Switch Rj45 Emer Check-in
AP	Rauland	TCC2099	Universal Mounting Kit
1	Rauland	TCC2055	Telecenter Campus Prog Module
1	Rauland	TCC2045	Telecenter Campus Ip Console
AR	Rauland	TCC2022	Telecenter Campus Zone Module
OFP	Rauland	TCC2011A	Telecenter Campus Ip Module 2
1	Rauland	TCC2000	Telecenter Campus Controller
OFP	Rauland	BAFKIT1X2S70V	Drop Tile Loudspeaker
OFP	Rauland	ACC1400	Hard Lid Speaker
OFP	Rauland	ACCWB5	Mtl Wall Baffle W/us0188 Spkr
OFP	Rauland	ACC3011FBB	Acc3011s Surface Mount Back Box - FLUSH
OFP	Rauland	ACC3011SBB	Acc3011s Surface Mount Back Bx-SURFACE
1	Rauland	ACC3011S	Message Board Speaker Baffle
1	Rauland	ACC3011S	Message Board Speaker Baffle
AR	LEA	CONNECT 168	Zone Amplifier
OFP	ATLAS	VTF-157-UCN	Flush mount exterior horn
OFP	Emtech	MSC-V10W	Volume Control 10 Watt White
AR	Middle Atlantic	PD-915R	9OUT15ARCKMNT POWER CEN
AR	West Penn	25355BYE	4C 22G SLD (2S/2UN)PLENII
AR	West Penn	254246EZYE	4P 23G SLD CAT 6 PLENUM

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. Furnish and install all material, devices, components and equipment for a complete operational system.

C. Impedance and Level Matching: Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.

D. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.

E. All housings are to be located as indicated.

F. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

G. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

H. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.

I. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

J. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.3 GROUNDING

A. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

C. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

C. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.5 FINAL ACCEPTANCE TESTING

A. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.

B. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.

C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.6 COMMISSIONING

A. The contractor shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 1.6 of these specifications. In addition to the Training Materials provided, the contractor will also furnish Operators Manuals and Users Guides at the time of this training.

B. Schedule training with Owner through the owner's representative, with at least seven days advance notice.

3.7 OCCUPANCY ADJUSTMENTS

A. The contractor shall provide Occupancy Adjustments in accordance with Section 1.6 of these specifications. A response scenario amenable to both the owner and the contractor will be established and followed for the first year of service.

3.8 CLEANING AND PROTECTION

A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

END OF SECTION

SECTION 275118 - SOUND SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes equipment for the Gymnasium and Cafetorium Sound Systems.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
B. Zone: A separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 SYSTEM COMPONENTS

A. Components as indicated on the plans, is section 2.3. This list on components for each system is not a complete list but a baseline for the major components. Provide additional components as required for complete and operational systems.
B. Provide adjustable delays and controls for systems that are indicated to have multiple zones.
C. Provide system components, installation and programming as required for complete sound systems in each area as outlined in the bid documents.
D. Any alternate systems must be approved a minimum of 10 days prior to bid date. Any alternate systems must be provided as a line by line document containing manufactures cut sheets from both the specified system and proposed alternate system. Any alternate system that does not meet or exceed current specification line by line, will not be approved.

1.5 SUBMITTALS

A. The submittal package shall include the following, grouped by system location (i.e. Gymnasium, commons, etc.):
1. Installer and supplier qualifications.
2. A list of components and quantities for each piece of equipment.
3. Product data for each piece of equipment in order matching the list of components.
4. Indicate the specific product part number and options if more than one is listed in the data.
5. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection. Include control panel layouts, rack layouts and wiring diagrams for each system.
6. Maintenance data, where applicable.
7. Warranty information.

1.6 QUALITY ASSURANCE

A. Installer and supplier Qualifications:
1. The approved installer must be an authorized representative of equipment manufacturer for installation, programming, and maintenance of equipment required for this section.
2. Installer to be able to provide factory and manufacturer programming certifications and be able to provide proof of certification prior to bid. (ie BSS, JBL, pro level Bose, etc.) and other listed manufacturers.
3. Installer to have a full-time engineering staff including a full-time draftsman.
4. Must be able to provide as a company a minimum of 10 years' experience of designing, installing and equalization of sound systems of similar magnitude.
5. Proper licensing for public works.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction.

C. Comply with the NEC.

D. Comply with UL 50.

E. The contractor shall guarantee availability of service by factory-trained personnel of all specified equipment from an authorized distributor of all equipment specified under this section. On-the-premise warranty shall be provided at no cost to the owner for a period of one (1) year (parts and labor) from date of project acceptance. All electronic products shall be covered by a five (5) year parts warranty from the date of project acceptance. The warranty period shall begin on the date of acceptance by the owner.

F. Equipment manufacture to provide a written 5-year parts warranty for all electronic equipment.

G. Testing

1. Instrumentation: The AV Contractor shall provide the following test equipment for use during initial tests and adjustments and during acceptance testing and final adjustment of the system:
2. Sound Level Meter: Shall meet ANSI S1.4 specifications for Type I sound level meters. SMAART with a Type I microphone and calibrator is acceptable.
3. Sine Wave Generator: Continuously variable from 20 Hz to 20,000 Hz within +1 dB with less than 0.5% THD.
4. Pink Noise Generator: Generator shall produce at least 1-volt RMS of pink noise.
5. AC Voltmeter: With frequency response of +1 dB from 20 to 20,000 Hz, 0.0001 volts to minimum input impedance of 0.1 megohm.
6. Data Communications Cable Verifier: Fluke MicroScanner2 or equivalent.
7. Polarity checker: Studio Six Digital AudioTools speaker polarity module or equivalent.
8. All other equipment required to conduct tests, equipment setup and checkouts outlined in this specification.

H. System compliance testing and documentation. The Contractor shall perform the following tests and provide a compliance document confirming the results of all tests prior to the final Consultant site visit.

1. Audio System Tests:
   a. Cabling:
      i. Check each microphone and line level cable for continuity of all conductors. Verify connectors are terminated and grounds are isolated using heat shrink. Document compliance on each line.
      ii. Check each loudspeaker line for continuity. Positive polarity shall be marked with red or white. Negative polarity shall be marked with black.
      iii. Data communications cabling shall be tested with a cable verifier. Document compliance.
   b. Loudspeaker Physical Alignment:
      i. Verify the height, vertical angle, and horizontal angle of all loudspeakers with a laser inclinometer. Document the measured aiming angles.
   c. Loudspeaker Line Impedance:
      i. Measure and document the impedance of each loudspeaker and associated loudspeaker line. Using an audio impedance meter (not DC resistance).
      ii. Measure full range loudspeaker impedance at 200 Hz and 2000 Hz.
      iii. Measure subwoofer impedance at 50 Hz and 100 Hz. Measure high frequency driver impedance at 4000 Hz and 8000 Hz. A full range impedance sweep using a software impedance meter is also acceptable.
   d. Loudspeaker Polarity:
      i. Perform polarity checks on all independent loudspeakers. Loudspeakers utilizing active crossovers shall have polarity checked on all individually amplified components. Results from all polarity checks shall be included in compliance documentation.
   e. Freedom from Buzzes, Rattles and Objectionable Distortion:
      i. Apply a slow continuous sine wave sweep at a level 3 dB below rated power amplifier output voltage. Listen carefully for buzzes, rattles, and objectionable distortion. Correct any causes of these defects, unless the cause is clearly outside the sound amplification system equipment and installation, in which case, the cause shall be brought to the attention of the Consultant.

ii. Listen for audible buzzes or noise in the audio system. Coordinate the operation of other building equipment, including but not limited to dimmers, motors, stage lifts, and HVAC equipment to ensure that normal operation of such devices does not cause audible noise in the sound system.

f. Gain Control Settings:

i. Establish tentative normal settings for all gain controls. All gain controls on rack-mounted equipment shall be adjusted for optimum signal-to-noise ratio and signal balance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturers: As listed in section 2.3 or pre-bid approved equal.

2.2 EQUIPMENT

A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions. Provide all mounting and support hardware for all equipment and devices.

B. Provide all power distribution/conditioning, remote power control, power sequencers and related equipment for each system.

C. Equipment: Modular type, using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

D. Mixers: Provide all input/output (I/O) cards for each separate system as required for complete and operational systems.

E. Wireless Microphones: Provide all devices, power supplies, remote mount kits, pre-manufactured low loss antenna cables and all related devices and equipment for a complete installation.

F. All Auxiliary Input Jacks shall be 3.5mm/1.8” with stereo connections. The jacks shall can accept stereo devices. Each system is a mono system, provide signal combiner for each aux jack and make connections as required between devices and equipment as required. The signal combiners shall be located in the corresponding rack. Provide power supplies as required.

G. Record Out Jacks shall be 3.5mm/1/8” with stereo connections. The Record Out jack shall provide the same signal that is being recorded to allow the content to be recorded on a mobile device. The jacks shall be capable of sending a stereo signal but the Left and Right channels will be the mono source. Provide and install line level a signal amplifier for each record out jack and make connections as required between devices and equipment as required. The signal amplifiers shall be located in the corresponding rack. Provide power supplies as required.

H. All sound system face plates shall be stainless steel.

I. Assisted Listening devices indicated below are on a per system basis. Provide a separate channel for each system to prevent crossover between systems.

2.3 COMPONENTS

A. Gymnasium Sound System

1. Components:

Quantity	Make	Part Number	Model	Description
1	BSS	BLU-100	BLU-100	Digital Signal Processor
1	BSS	EC-8BV-WH	EC-8BV-WH	Wall Control
1	BSS	CONTRIOSRVR-DVS	CONTRIOSRVR-DVS	Soundweb Contrio Soundcard Version
3	Crown	DCI 2/300		Power Amplifiers
1 per spkr	JBL	MTC-30U-WH (B)		Mounting brackets
As shown	JBL	Control 30-1		watt Speaker.
1	NMX-Enet-300-Mpp	NMX-Enet-300-Mpp	NMX-Enet-300-Mpp	AMX Ethernet Switch

1	Audio technica	10 PRO	ATW-1301	Lapel Wireless Microphone System
1	Audio technica	10 PRO	ATW-1302	Handheld Wireless Microphone System
1	Audio technical	10 PRO	ATM75	Headworn microphone
1	Listen	LS-54-072	LS-54-072	ALS System
AR	RDL	D-J3	D-J3	Mic/Aux Jack
AR	RDL	D-XLR2M	D-XLR2M	Dual Male Jack
1	Atterotech	unBT2A	unBT2A	Bluetooth system
1	Middle Atlantic	DWR-24-22	DWR-24-22	Wall Equipment Cabinet
1	Middle Atlantic	LVFD-24	LVFD-24	Front Door
1	Middle Atlantic	DWR-RR24	DWR-RR24	Rear Rack Rails
1	Middle Atlantic	PD-920R	PD-920R	Power Distribution
1	Middle Atlantic	EB1-CP12	EB1-CP12	Blank Panels Contractor Pack
1	Middle Atlantic	LBP-1R4	LBP-1R4	Lacing Bars
1	Middle Atlantic	LBP-1.5	LBP-1.5	Lacing Bars
1	Middle Atlantic	BR1	BR1	Brush Guard
1	Middle Atlantic	UPS-S1000R		Power Supply
2	AKG	D5S	D5S	Handheld Vocal Microphone
2	Whirlwind	MK450	MK450	50' Mic Cord
1	Middle Atlantic	IUQFP-2D	IUQFP-2D	Blower Panel
1	Middle Atlantic	PDT-1020C-NS	PDT-1020C-NS	Power management
AR	West Penn	25454	25454	Mic Line
AR	West Penn	254246	254246	Cat 6
AR	West Penn	25227	25227	Speaker Cable

2. The equipment rack shall be wall mounted and shall contain all rack mounted equipment for this system including storage drawers. Provide and install blank covers for all unused rack space.
3. Provide, install and program all required modules and system components for the digital system.
4. There shall be one mixer output for each amplifier channel. Provide equipment and programming as required to set the proper delays for each channel so the amplified audio is delivered in unison.
5. The remote antennas shall be protected with a wire guard. Provide and install a wire guard that is large enough to allow the antennas to be adjusted in any direction. The antennas shall be aimed to provide the widest range of coverage in the gym space. Set the amplifier gain structure as per industry standard.
6. Provide and install one Microphone and one Auxiliary Input jack in the floorbox in the Gymnasium.
7. Provide and install be one Microphone and one Auxiliary Input jack located in the face on the motorized bleachers in the Gymnasium
8. Provide and install Microphone and Auxiliary Input jacks at the locations indicated on the plans for this system.
9. The Wall Control Panels shall be flush mounted at the locations indicated on the plans.
10. Assisted Listening Equipment. Provide at least 36 Assisted listening devices. A minimum of 9 of these devices shall be hearing-aid compatible per IBC 1108.2.6. Provide all required system components, amplifiers, transmitters, antennas, cabling, ect as required for a fully operational system.

B. Cafetorium Sound System
   1. Components:

Quantity	Make	Part Number	Model	Description
1	BSS	BLU-100	BLU-100	Digital Signal Processor
1	BSS	EC-8BV-WH	EC-8BV-WH	Wall Control

1	BSS	CONTRIOSRVR-DVS	CONTRIOSRVR-DVS	Soundweb Contrio Soundcard Version
3	Crown	DCI 2/300		Power Amplifiers
1 per spkr	JBL	MTC-30U-WH (B)		Mounting brackets
As shown	JBL	Control 30-1		watt Speaker.
1	NMX-Enet-300-Mpp	NMX-Enet-300-Mpp	NMX-Enet-300-Mpp	AMX Ethernet Switch
1	Audio technica	10 PRO	ATW-1301	Lapel Wireless Microphone System
1	Audio technica	10 PRO	ATW-1302	Handheld Wireless Microphone System
1	Audio technical	10 PRO	ATM75	Headworn microphone
1	Listen	LS-54-072	LS-54-072	ALS System
AR	RDL	D-J3	D-J3	Mic/Aux Jack
AR	RDL	D-XLR2M	D-XLR2M	Dual Male Jack
1	Atterotech	unBT2A	unBT2A	Bluetooth system
1	Middle Atlantic	DWR-24-22	DWR-24-22	Wall Equipment Cabinet
1	Middle Atlantic	LVFD-24	LVFD-24	Front Door
1	Middle Atlantic	DWR-RR24	DWR-RR24	Rear Rack Rails
1	Middle Atlantic	PD-920R	PD-920R	Power Distribution
1	Middle Atlantic	EB1-CP12	EB1-CP12	Blank Panels Contractor Pack
1	Middle Atlantic	LBP-1R4	LBP-1R4	Lacing Bars
1	Middle Atlantic	LBP-1.5	LBP-1.5	Lacing Bars
1	Middle Atlantic	BR1	BR1	Brush Guard
1	Middle Atlantic	UPS-S1000R		Power Supply
2	AKG	D5S	D5S	Handheld Vocal Microphone
2	Whirlwind	MK450	MK450	50' Mic Cord
1	Middle Atlantic	IUQFP-2D	IUQFP-2D	Blower Panel
1	Middle Atlantic	PDT-1020C-NS	PDT-1020C-NS	Power management
AR	West Penn	25454	25454	Mic Line
AR	West Penn	254246	254246	Cat 6
AR	West Penn	25227	25227	Speaker Cable

2. The equipment rack shall be wall mounted and shall contain all rack mounted equipment for this system including storage drawers. Provide and install blank covers for all unused rack space.
3. Provide, install and program all required modules and system components for the digital system.
4. There shall be one mixer output for each amplifier channel. Provide equipment and programming as required to set the proper delays for each channel so the amplified audio is delivered in unison.
5. The remote antennas shall be protected with a wire guard. Provide and install a wire guard that is large enough to allow the antennas to be adjusted in any direction. The antennas shall be aimed to provide the widest range of coverage in the gym space. Set the amplifier gain structure as per industry standard.
6. Provide and install one Microphone and one Auxiliary Input jack in the floorbox in the Gymnasium.
7. Provide and install be one Microphone and one Auxiliary Input jack located in the face on the motorized bleachers in the Gymnasium
8. Provide and install Microphone and Auxiliary Input jacks at the locations indicated on the plans for this system.
9. The Wall Control Panels shall be flush mounted at the locations indicated on the plans.
10. Assisted Listening Equipment. Provide at least 36 Assisted listening devices. A minimum of 9 of these devices shall be hearing-aid compatible per IBC 1108.2.6. Provide all required system components, amplifiers, transmitters, antennas, cabling, ect as required for a fully operational system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment to comply with manufacturer's written instructions.
B. Install the caster kit for the wall mounted racks to support the center section of the rack where indicated.
C. All speakers located in grid ceilings shall have support that spans the grid, insulated back boxes and tied off to structure as required by code.
D. Wiring Method: ALL 8Ω speaker wiring shall be in separate conduit from all other cables. Provide flex connection to all speakers, coordinate flex connection to speakers and speaker back boxes. All microphone, aux input, remote volume controls, on/off control, record out, etc shall be in conduit. See Section 260533 for conduit requirements.
E. Speaker Wiring: The quantity of speakers shall be balanced between the available channels on the amplifiers for each system. The systems are made up of 2 channel and 4 channel amplifiers. All channels on each amplifier shall be used.
F. Balanced Wiring: All audio circuits shall be balanced throughout the system.
G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.
H. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.
I. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
J. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
K. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
L. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.
M. Wall-Mounting Outlets: Flush mounted.
N. Weatherproof Equipment: Install units that are mounted outdoors, in damp locations, or where exposed to weather consistent with requirements of weatherproof rating.
O. Line Matching Transformers: Adjust the transformer taps as required for optimal system performance.
P. Testing: Contractor shall test each input channel individually and as a mix to ensure the proper settings are applied to the mixers, delays, amplifier gain.
Q. Manual Mixers: Contractor shall provide proper settings for each channel. The optimal level shall be labeled for each channel on the mixer.
R. Digital Mixers: Contractor must be factory certified and shall provide programming for each input and output. Provide the optimal settings for each channel. Utilize manufactures software to program the equipment. Provide programming for the remote unit associated with each digital mixer. Install the Security cover over the digital mixer controls.
S. Wireless Systems: The contractor shall coordinate the programming of the wireless system bands and frequencies based on data from the manufacture for the local area. The settings shall prevent the separate systems from interfering with each other if all systems on the campus are all operating at the same time. The settings shall also be coordinated with the auditorium wireless systems specified and provided by other divisions.
T. Handheld microphones, wireless microphones, transmitters, cables and related equipment to be stored in the equipment rack for each system.
U. Provide blank plates for all un-used junction box gangs.
V. Assisted listening devices to be stored in a separate drawer from the other equipment.
W. Labeling: Engineered labels are required. All labels shall be machine printed with permanent black ink on white background.
    1. Digital Mixers: Label each input/output as to the source/destination.
    2. Digital Mixer Remote: Label each input fader at to the source, each volume control as to what speaker(s) it controls, each switch as to it specific function.
    3. Manual Mixers: Label each input/output as to the source and destination. Label each level control as to the source that is connected. Also, label each channel as to the proper setting for normal operation.
    4. Amplifiers: Label each amplifier as to the speakers or sets of speakers it supplies, label each amp channel as to the speakers it supplies. Label each adjustable dial as to the proper setting for normal operation.
    5. Provide engineered label for each wire as per engineered shop drawing, as to its source and destination for all systems.
    6. Label the drawers as to the contents and quantities stored in each drawer.

7. Wireless Microphone Systems: Label each transmitter and receiver with the location and mic number. For the systems that have a handheld and a body pack tied to the same receiver, provide a label on the inside of the rack door that explains that only one of the microphones for receiver # may be used at a time.
8. Label each key as to which system and component it is for.

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
C. Audio circuits shall also observe the grounding practices outlined in “Sound System Engineering”, Don Davis, 1987, SAM Press.

3.3 FIELD QUALITY CONTROL

A. Operational Test: Perform tests that include originating program and page material at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and freedom from noise and distortion. Correct deficiencies and retest, if required.
B. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel and the engineer to adjust, operate, and maintain equipment.
1. Train owner’s maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals.

END OF SECTION 27 51 18

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SECTION 275200 - CLASSROOM AUDIO SYSTEM

PART I – GENERAL

1.1 QUALITY ASSURANCE

A. Qualifications

1. Installer Qualifications: Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
   a. Certificate: when requested, submit certificate indicating qualification.

2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction, approving acceptable installer and approving application method.

B. Acceptable Manufacturers

1. Basis of Design: Lightspeed Technologies, 11509 SW Herman Road, Tualatin, OR 97062, PH 800-732-8999, FAX 503-684-3197

C. Manufacturer Testing: Manufacturer to provide quality assurance certification for each system and all of its components. A report for each system will be available upon request. Report will include serial numbers and pertinent testing data for all of the system functions.

D. Successful third-party installation (when needed) will be supplied with necessary training to allow for product installation certification by Manufacturer and will be installed according to Lightspeed recommendations.

1.2 SUBMITTALS

A. General: Submit listed submittals in accordance with “Conditions of the Contract”.

B. Manufacturer’s data on all products including but not limited to:

1. Catalog cut sheets
2. Installation instructions
3. Typical wiring diagrams
4. Drawings showing speaker locations
5. Operation and maintenance manuals
6. Manufacturer’s warranty documents
7. Manufacturer’s parts lists
8. Product serial numbers

1.3 WARRANTY

A. Warranty: Refer to “Conditions of the Contract” for warranty and repair provisions.

B. Repair: Manufacturer shall offer repair service on all Classroom Audio components. Owner shall pre-pay shipping for all items returned to manufacturer for repair. The Manufacturer shall repair or replace system components as specified under warranty. Manufacturer shall ship repaired components within five (5) working days of receipt. Items returned to Owner are shipped via the same method in which they were received.

C. Manufacturer's Warranty: All the major system components (transmitters, receiver-amplifier, sensor, and speakers) must be warranted for five years against defects occurring while used in normal classroom instruction. The warranty shall be equivalent to a Lightspeed Technologies' Five-Year Warranty.

1. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.

1.4 OVERALL SYSTEM DESCRIPTION

A. The system must have specifications and features that are equivalent to the Lightspeed Topcat® In-Ceiling Classroom Audio System including the following:

1. All-in-one, in-ceiling audio system with integrated amplifier, speakers and wireless audio receiver/transmitter
2. Two-way hybrid speaker system with exciter technology sound panel and low frequency cone driver
3. Cross over technology to deliver high speech intelligibility and full range sound with even distribution throughout the classroom
4. Up to 2 microphones for whole room instruction, team-teaching or student sharing
5. Pendant-style Flexmike® classroom microphone with audio input utilizing Access Technology (1.9 GHz) for transmission. IR not acceptable
6. Wireless Media Connector utilizing Access Technology (1.9 GHz) to integrate with and wirelessly transmit all classroom multimedia to be played through the Topcat.
    a. Includes 4 audio inputs with volume control
    b. 2 audio outputs for ALD and/or recording with volume control
    c. Tone control to remotely adjust bass/treble of Topcat
7. Must have PageFirst emergency page priority with all Topcat installations
8. In-Ceiling mounted
9. Suitable for use in air-handling spaces (plenum-rated)
10. Compatible with Flexcat speaker pods with 2-way audio communication.

B. The system must produce high speech intelligibility and full-range multimedia quality sound with excellent distribution throughout a classroom.

C. The system must be capable to be installed in a classroom with no wires installed in or on the walls. The system must be fully operational without speaker wires or sensor cables.

D. The system must be compatible and expandable to operate with 2-way small group speaker pods allowing interoperability between both small group and whole group instruction.

E. The system shall carry a "No Audio Dropout Guarantee" between the wireless microphone and the sound system. The guarantee applies to operation in any room up to its expected range of 200 feet (assuming no walls). The guarantee does not extend into other rooms separated by walls as this can limit transmission range significantly. Should any dropout in audio transmission occur, the manufacturer will correct it at no additional charge.

F. The system shall carry a standard warranty equivalent to the Lightspeed 5-year Warranty.

1.5 OWNER INSTRUCTION

A. Owner's Instruction: user-training will be performed by the manufacturer's local representative. The training will include the research and benefits of classroom amplification, system operation, simple troubleshooting guidelines, and incorporating the classroom amplification into teaching styles. The manufacturer will also provide additional training in trouble-shooting techniques and product return procedures to one specified person per campus. This service shall be rendered to the Owner at no additional cost.

B. Instruction materials and detailed Owner's manual shall be provided to cover operational and basic maintenance procedures.

PART 2. PRODUCTS

2.1 IN-CELING CLASSROOM AUDIO SYSTEM SPECIFICATIONS

A. Overall System:

1. Power output: 20 Watts rms
2. Acoustic Frequency response: 60 Hz to 18 kHz -10dB
3. AC Mains Power Input: 100-240V ~ 50/60Hz 1.5A
4. DC Power Input: 24V/2.5A
5. Signal-to-noise: 60 dB
6. Total Harmonic Distortion: <1%, 10 W
7. Wireless Communication: Access Technology (1.9 GHz + RF4CE)
8. Automatic power down after 2 hour of inactivity
9. Automatic power on when Flexmike is powered on and linked
10. Dimensions (W x D x H): 24" x 12" x 3.7" (Removable side spacers to fit international ceiling grids; 595mm x 295mm x 94mm)
11. Weight: 13.5 lbs (6.1 kg)
12. Controls:
    a. (1) Microphone volume control
    b. (1) Tone control
    c. (1) Audio input volume control
    d. (1) PageFirst sensitivity adjustment
13. Connections:
    a. (1) Direct AC mains power input
    b. (1) Optional DC Power Input
    c. (1) Audio input
    d. (1) Optional Page mute (PageFirst™) input (Euro-block)
14. Device Registration: push button for transmitter(s), remote(s), speaker pods
15. Wireless audio range: up to 200 feet
16. Integrated 2-Way Hybrid Speaker System:
    a. Description: exciter technology sound panel plus low frequency cone driver
    b. Integrated cross-over technology
    c. Panel Size: 13.75" x 6.75"
    d. Cone Driver Size: 5.25"
    e. Overall Frequency Response: 60 Hz to 18 kHz -10dB
    f. Impedance: 8 Ω
    g. Power Handling: 25 W

B. The in-ceiling classroom audio system shall use bi-directional wireless Access Technology to communicate with up to two wireless microphones.

C. The in-ceiling classroom audio system shall use bi-directional wireless Access Technology to integrate with other audio sources in the classroom.

D. The in-ceiling classroom audio system shall use bi-directional wireless Access Technology to send a mixed audio output to a media connector located at a convenient/student accessible location in the classroom.

E. The in-ceiling classroom audio system shall use bi-directional wireless Access Technology to communicate with up to 6 optional tabletop speaker pods available to facilitate small group instruction.

F. The all-in-one system must contain a Page mute function (PageFirst™) that passively detects the audio signal of a page coming through the PA system without compromising system performance or voiding warranties. As an audio signal is sent to the PA speaker, the PageFirst passive sensor clip detects that signal and immediately mutes the Topcat.

2.2 WIRELESS MEDIA CONNECTOR

A. Description: Wireless audio transmitter/receiver to itegrate with classroom audio sources and send/receive the wireless to the Topcat system in the ceiling.

B. Wireless Communication: Access Technology (1.9 GHz)

C. Audio Inputs: (4) 3.5mm stereo jacks connect to classroom audio sources.

D. Audio Outputs: (2) 3.5mm jack with volume control

E. (1) Microphone volume control

F. (1) Audio input volume control

G. (1) Audio output volume control

H. (1) Power button with LED

I. (1) Tone control

J. (1) Registration button with Registration LED and linked LED

K. Audio frequency response: 80 Hz to 7 kHz ±3 dB

L. Audio distortion: <1%

M. DC Power Input: USB 5V/0.2A (type micro-B)

N. Mounting: table-top or wall

O. Dimensions (W x D x H): 7.6”x 4.1”x 1.1” (193 x 104 x 28mm)

2.3 FLEXMIKE PENDANT-STYLE MICROPHONE / TRANSMITTER

A. Description: the pendant-style wireless microphone

B. Lanyard: adjustable length with magnetic clasp

C. Wireless communication: bi-directional Access Technology (1.9 GHz)

D. Audio distortion: <1%

E. Integrated microphone type: uni-directional electret

F. Audio input: 3.5mm

G. Earbud output: 3.5mm (for to monitor optional Flexcat pods)

H. Push button volume control: +/- 6dB (total range = 12 dB)

I. Power: on/off/mute button

J. Battery Power: 2.4V NiMH battery pack

K. Battery run time: 8 hours (fully charged)

L. Charging: 5V USB; type micro B connector

M. Alkaline Charge Protection: Yes

N. USB Audio: interface with computer USB audio while charging

O. Registration: push button for registration with Topcat

P. Dimensions (L x W x H): 2.9” x 1.1” x 1.0” (74 x 28 x 25mm)

Q. Weight: 1.8 oz (51g)

2.4 OPTIONAL SHAREMIKE HANDHELD MICROPHONE / TRANSMITTER

A. Description: handheld wireless microphone

B. Wireless communication: Access Technology (1.9 GHz)

C. Audio distortion: <1%

D. Integrated microphone type: uni-directional electret

E. Auxiliary Input: 3.5mm

F. Power: on/off/mute button

G. Battery Power: 2 AA NiMH rechargeable battery pack

H. Battery run time: up to 8 hours (fully charged)

I. Charging: 5V USB; 3.5mm DC jack

J. Alkaline Charge Protection: Yes

K. Registration: push button for registration with Topcat

L. Dimensions (L x W x H): 8.25” x 1.3” x 1.3”

M. Weight (with batteries): 7.9 oz

2.5 REGULATORY AND CERTIFICATIONS

A. The classroom audio system and its components shall be manufactured using lead-free processes and free of other materials harmful to the environment (RoHS and WEEE compliant).

B. The classroom audio system and its components shall be listed to UL/CUL standards and requirements for electrical safety by Underwriters Laboratories Inc.

C. The classroom audio system must be suitable for use in air handling spaces and carry appropriate certifications (UL 2043).

D. The classroom audio system and its components shall be CE Certified and conform with the essential requirements of the following European Union Directives: 2004/108/EC Electromagnetic Compatibility (EMC) and 2006/95/EC Low Voltage Directive (LVD).

E. The classroom audio system and its components shall comply with Part 15 of the FCC rules as a Class B digital device (FCC Certified).

PART 3. EXECUTION

3.1 SYSTEM PERFORMANCE

A. Install in accordance with Manufacturer's installation instructions.

B. Final adjustment: Upon completion, the system shall be clean, adjusted and left in perfect operating condition. Transmitters shall be plugged in and charging and user manual should be left in a conspicuous place.

C. Provisions: There shall be no audible components of hum, noise, or distortion.

3.2 INSTALLATION

A. Provide and install Sound Reinforcement System in the locations shown on drawings as required.

B. All equipment and enclosures described in this specification shall be permanently attached to the structure and held firmly in place. Supports shall be adequate to support their loads per manufacturers specifications.

C. The process of testing the Audio Sound System may necessitate moving and adjusting certain component parts (ex. loud speakers). Contractor shall provide at no additional cost to the owner.

D. Take precautions as necessary to prevent and guard against electromagnetic and electrostatic noise interference.

E. Wireless Media Connector to be located per Owner's request. Contractor to ensure all Media Connectors are properly registered and all volume controls are set properly via a field test in every classroom. Ensure power is available for Media Connector.

3.3 INTEGRATING THE TOPCAT WITH OTHER AUDIO SOURCES

A. The wireless Media Connector must have four audio inputs to allow other audio sources to be wirelessly transmitted and played through the Topcat system. Computers, DVD/VCR's, TV's, CD's, MP3's etc. may be connected into the Media Connector using appropriate patch cords. The Media Connector must also receive audio back from the Topcate to output the mixed audio signal of both microphone channels and multimedia for recording purposes and interface with assistive listening devices. See the systems integration chart below.

END OF SECTION 275200

SECTION 281000 - ACCESS CONTROL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes a microprocessor based and managed access control system and specifies door status sensors, card readers, network controllers and nodes, and system management equipment based on a network platform.

1.3 DEFINITIONS

A. Hard-Wired System: Alarm, supervisory, and detection devices are directly connected, through individual dedicated conductors, to distributed door controller panels and networked together.

1.4 SYSTEM DESCRIPTION

A. The main system network controller shall be provided to the School District as part of this school's access control installation. The intent is to have this main controller installed at the main administration offices for control of future access control system installations in other schools in the district. The contractor shall be responsible for the set up and programming of the entire system, including the main network controller. The School District shall be responsible for a functioning WAN to the new school for connection to the distributed network nodes.

B. The system shall support both manual and automatic responses to alarms entering the system. Each alarm condition shall be capable of initiating numerous events including but not limited to the activation of remote devices, door control, and card validation. A card reader shall be provided in the overall system for a "Lockdown" function that shall interface with the access nodes and magnetic door holders. Interface and coordination shall be required with the fire alarm system in connection with the magnetic door holders.

C. Access control functions shall include but not be limited to card validation based on time of day and day of week, holiday scheduling with validation override, and positive verification of card.

D. In addition to the magnetic doors holders, the system shall interface with the fire alarm system and in the event of an alarm, be programmed to release all and/or selected controlled doors that are without free egress, and put them into "access", or unlocked mode, until directed to relock. Doors to be released by system command shall be coordinated with the local authority having jurisdiction through the Architect.

E. Provide an integrated photo identification badging and video verification system. This system would be used to produce badges on standard HID proximity cards, load the cardholder database, perform video verification identity checks and provide badge design facilities.

F. The system's primary purpose shall be to provide access control. The system shall be able to make access decisions and define access levels. The system shall support features such as area control and time zone holiday overrides. The system shall be used secondarily for alarm monitoring

1.5 DESCRIPTION OF WORK

A. The security control system shall manage the security operations for multiple sites. Installing the system and bringing it to operational status requires the following major steps:
   1. Determine operational requirements and provide system to implement those requirements.
   2. Configure, where necessary, the communications network providing communications between the various system components.
   3. Install and integrate access control, alarm monitoring and related integrated security hardware.
   4. Configure local card access panels and computer system to communicate with one another.
   5. Enter security system database information and integrate with existing corporate cardholder database.
   6. Connect between host system; access panels, and related hardware.
   7. Test security system communication and operation.
   8. Train various levels of operators, including system administrators, guards and card input operators.

1.6 FUNCTIONAL PERFORMANCE

A. The system shall consist of intelligent network nodes used in a distributed processing configuration. Each node shall retain all data necessary for system operation in its own RAM. Each node will contain an integrated real time clock that will continue to govern events even if communication with the host network controller is interrupted.

1.7 SUBMITTALS

A. General: Submit the following according to General Conditions Section.

B. Product data for system components, including “Nationally Recognized Testing Laboratory” (NRTL) listing data and list of materials, dimensioned plans, sections, and elevations showing minimum clearances, mounting arrangements, and installed features and devices.

C. Wiring diagrams for system, including all devices, components, and auxiliary equipment. System diagram is unique to the Project system; a manufacturer’s generic system diagram is not acceptable. Diagrams shall differentiate between manufacturer-installed and field- installed wiring. Include diagrams for equipment and for system with all terminals, interconnections, cable types and sizes and specific rough in requirements identified.

D. System operation description, including method of operation and supervision of each component and each type of circuit, and sequence of operations for all manually and automatically initiated system inputs, and all specialized functions as listed above. Description must cover this specific project; manufacturer’s standard descriptions for generic systems are not acceptable.

E. Operation and maintenance data for inclusion in “Operating and Maintenance Manual” specified in General Conditions Section. Include data for each type product, including all features and operating sequences, both automatic and manual. Include user’s software data and recommendations for spare parts to be stocked at the site. Provide names, addresses, and telephone numbers of service organizations that stock repair parts for the system.

F. Product certifications signed by the manufacturers of system components certifying that their products comply with the referenced standards.

G. Separate Qualification Data for Manufacturers and Installers: Demonstrate their capabilities and experience as specified in Quality Assurance Article. Include lists of completed projects with project names and addresses, names of Engineers and Owners, plus other information specified.

H. Record of field tests of system.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a factory authorized sales and services representative of the system submitted. At the time of bid, the bidder shall have staff with a minimum of 5 years of experience installing systems of similar size, complexity, and general operation as the system described in this specification. When requested to do so, the installer shall furnish, in writing, proof of compliance with system manufacturer's current service and installation certification programs. Installer must be capable of providing emergency maintenance and repairs for the overall system at the project site with 24 hours maximum response time. the installer shall have access to a local office staffed with factory trained technicians, fully capable of supervising installation, system start-up, providing training and servicing of both hardware and software for systems of similar complexity and function as the system described in this specification.

B. Comply with NFPA 70, "National Electrical Code."

C. Listing and Labeling: Provide system and components that are listed and labeled for their indicated use and location on the Project.
1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. Comply with UL Standard 609, 1023, and 1076.

E. FM Compliance: Provide FM-approved card access system and components.

F. Single-Source Responsibility: Obtain system components from a single source (the prime system manufacturer) that assumes responsibility for system components and for their compatibility.

G. Coordination of Work: Coordinate the Work of this Section with the requirements of the Owner's security procedures and policies.
1. Meet jointly with the representatives of the Owner to exchange information and agree on details of installation interfaces, any work involving, but not limited to, specific programming, partitioning, card reader restrictions, alarm annunciations, and any other circumstances that impact on the completion of the work of this Section.
2. Record agreements reached in the meeting and distribute the record to the other participants.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Security Control System Software: Prebid prior approval required for control system software. Provide submittal 14 days prior to bid date for review and approval.
2. Security Control System Physical Hardware: Prebid prior approval required for control system software. Provide submittal 14 days prior to bid date for review and approval.
3. Security Control System Field Hardware basis of design

a. Card readers: HID iClass SE prox readers, 125kHz and 13.56MHz compatible (iClass, MIFARE)
b. Door controllers IP: Mercury LP 15xx series
c. Door controllers nonIP: Mercury MR5x series

2.2 ACCESS CONTROL SYSTEM EQUIPMENT, GENERAL

A. Surge Protection: Comply with minimum requirements of UL Standard 1449, "Transient Voltage Surge Suppressors," for each component using solid-state devices and having a line voltage power source connection or an exterior underground signal connection.
B. The system includes a comprehensive and integral group of pre-planned hardware and software components, which derive their data from an industry standard relational database.
C. The system supplied shall have a distributed architecture and shall support the interface of various intelligent controllers.
D. Each control panel shall be capable of interfacing with most computer peripherals and major card reader technologies, in particular Hughes HID formats, without the necessity of special interfacing techniques. The system architecture shall be such that all pertinent information relating to the functionality of each network controller shall be downloaded and stored within, the applicable controller, such that all access decisions be made locally at the controller. Should communication with a file server be lost, all event activity shall be stored in the controller buffer, tagged with time of occurrence, until communication is restored, when they shall be automatically uploaded to the file server including the actual time of occurrence. This functionality shall enable any controller, when offline from the file server, to respond to all access decisions locally such that the full access control capability of the system shall not be adversely affected and a card user shall not be aware of the offline condition.
E. The Access/Alarm advanced processing field panel shall be a self-contained, microprocessor controlled field panel. The panel shall serve as the data collection and communications interface between the security control system and the various field devices such as card readers, alarm inputs and control outputs. The panel shall operate in local decision mode. Configuration information (i.e. card records, time commands, door/monitor point/control point configuration, etc.) shall be downloaded from a host system.
F. Provide at the locations identified, a completely operational Access Control System including but not limited to the following equipment:
1. Card Readers
2. Network controller
3. Network nodes
4. Access blades
5. All power supplies or transformers
6. All equipment, security devices, components, wire, cable, and mounting hardware as required to meet specification requirements and manufacturers documented installation procedures.

2.3 MODES OF OPERATION

A. Local Decision
1. The field panel shall be connected to the host computer via a hard-wired, Ethernet or dial up modem communication path. In the local decision mode, the field panel shall process activity based upon information resident in the field panel's memory. The field panel configuration and cardholder record information shall be downloaded from the host computer. Local decision events will be reported to the host computer for historical logging. Local decision events shall include access attempts, scheduled locking/unlocking of doors, schedule arming/disarming of alarm points, scheduled activation/deactivation of output relays, and linking output relays to the state of alarm points. While the field panel is not in communication with the host computer, the panel shall continue normal operation and shall utilize available memory for storage of off-line

events. Off-line events shall be reported to the host computer when communications are re-established.

2.4 CONSTRUCTION

A. Cabinet

1. The field panel shall be housed in a locking, minimum 18-gauge metal cabinet, suitable for wall mounting. All cabinet locks shall be keyed alike. The cabinet shall be equipped with a tamper switch on the front door. Tamper alarms shall automatically report to the host computer when activated. The cabinet shall be suitably sized to allow installation of the panel, all expansion modules and associated field wiring.

B. Modular Expansion

1. The field panel shall be expandable in a modular fashion, requiring only those modules necessary for the application. Where possible, expansion shall be accomplished via the use of field installable modular components. The supported modular components shall include card reader, reader communication wiring, and alarm input and relay control modules.

C. Wiring connections

1. Field wiring connections shall allow the replacement of modules without requiring the disconnection of field wiring.

2.5 COMMUNICATION

A. General

1. The communication between the field panel and the host computer shall be either a hard wire connection IP based network. Hard-wired systems may operate using RS232, RS485 or Ethernet communications protocols. Line drivers and fiber optic cabling/transceivers, specified by the field panel manufacturer, may be used to extend the RS232 length limitation. Multiple field panels connected to a single port on the host shall communicate utilizing either RS485 or Ethernet protocols.
2. Cable type, wiring configuration and grounding practices shall follow manufacturer's specifications.

B. Dial-Up Operations

1. The field panel shall provide the capability for remotely located units to communicate with the host computer using standard dial-up telephone lines. The field panel and host shall each be able to initiate communications using an encrypted password scheme for security. While a unit is operating in dial-up mode, all decision-making activity related to access, door, alarm and control point will be based upon information resident in the field panel memory.

C. Programming/ Data Downloading

1. Data necessary for the field panel to operate shall be programmed into the host computer. The host computer will perform the data downloads to the field panels. It shall not be necessary to perform programming locally at the field panel. The data to be downloaded to the field panel shall consist of configuration information and cardholder records. Only the information directly related to the operation of the individual panel shall be downloaded.
2. Configuration downloads shall include, but not be limited to, the system time and date as well as information related to scheduled activities, holidays, card reader doors, alarm monitor points and output relays. Configuration downloads shall automatically occur as modifications are entered into the host computer database. This download shall include only the modified data. A download of all configuration information shall automatically occur when a field panel recovers from a loss of communications with the host computer. A configuration download shall also occur in response to an operator command.

3. Cardholder record information shall be automatically downloaded to the appropriate field panel as modifications are made to the cardholder record.

2.6 DIAGNOSTICS

A. The field panel shall contain/support several means for determining the state of the panel. This shall include but not be limited to diagnostic LEDs, communications LEDs and a full function diagnostic program.
B. Each time the field panel is powered, the panel shall go through an automatic diagnostic cycle.
C. A full function diagnostic program shall be available to assist in the installation and troubleshooting of the field panel. The diagnostic program shall operate while the field panel is in either stand-alone or host communication mode, without causing interference with the normal operation of the panel.

2.7 CARD READERS

A. General
1. The proximity read head/antenna shall be available either housed in the reader housing with the reader module or as a mullion mount unit. Cable type, wiring configuration and grounding practices shall follow manufacturer's specifications.

B. Card and Reader Technology

1. The readers shall be of the proximity type transmitting at a frequency of 125 kHz and 13.56 MHz and shall be one of the following models deemed to be appropriate for the application. All versions shall include a multi-color LED and a beeper, which shall change state on presentation of a proximity card configured to be compatible with the reader. All readers shall also perform an internal self-diagnostics test and initialization on power-up.
2. The cards shall be of the proximity type receptive to a compatible 125 kHz reader. They shall be one of the following models deemed to be appropriate for the application. They shall not be affected by body shielding or variable environmental conditions even when close to keys or coins.
3. The mullion reader shall be a low profile reader in a weatherized polycarbonate housing suitable for mounting on metal in either an indoor or outdoor environment. It shall have a read range of 4" to 5.5" when used with a standard credit card sized access card.
4. The switchplate reader shall be a low profile reader in weatherized polycarbonate housing suitable for mounting on metal in either an indoor or outdoor environment. The housing shall be an industry standard switchplate, beige in color and as appropriate for the decor, and mount in an industry standard single gang electrical box. It shall have a read range of 4" to 5.5" when used with a standard credit card sized access card.
5. The standard reader shall be a low profile reader in weatherized polycarbonate housing suitable for mounting on metal in either an indoor or outdoor environment. It shall be a single piece reader, beige in color, which can mount on an industry standard single-gang electrical box. It shall have a read range of 5" to 9" when used with a standard credit card sized access card.
6. The extended range reader shall be a low profile reader in weatherized polycarbonate housing suitable for mounting on metal in either an indoor or outdoor environment. It shall be a single piece reader, charcoal gray in color, and shall have a read range of 18" to 24" when used with a standard credit card sized access card.

2.8 SOFTWARE

A. Software Capacities

1. The system software shall be upgraded to include the following features and be configured for minimum:
a. Audible alarm annunciation at operator workstation

b. Dial up remote diagnostics
c. Event scheduling
d. Field panel communications through various means including hardwired, dial-up and Ethernet network
e. The system software operator screens shall utilize all standard Windows style functions such as drag-and-drop menus, radio buttons, check boxes and list box. The system shall provide context sensitive help screen Windows to insure the users' ability to receive informational text pertinent to the task being performed.
f. The system server and workstation shall be interconnected via an industry standard Ethernet LAN utilizing either 10BaseT twisted pair, 10BaseT fiber optics or 100VG cabling.
g. The system shall be capable of providing breakthrough alarms to notify the operator of a high priority condition regardless of which applications software is open on the system.

2. The programming of the system shall allow the system operator to configure the system software and hardware in a logical flowing method.

B. Management Reports

1. The system shall provide a user-friendly report management tool integral to the system. The report generator shall allow reports to be generated from the following information locations:
   a. Archived history from either the online hard drive storage or the offline CD-ROM storage.
   b. Configuration data from the file server.
2. The system shall provide a minimum of five report templates that provide the following real-time information:
   a. Alarm status
   b. Input points status
   c. Output points status
   d. Door status
   e. Time period configuration
   f. Holiday configuration
   g. Input point configuration
   h. Output point configuration
   i. Access level definition
   j. Door level configuration
   k. Cardholder access level
   l. Cardholder configuration
   m. Door configuration
3. The system shall provide report templates that provide the following historical information:
   a. Cardholder history
   b. Designated tracking of groups, individuals and companies
   c. Alarm history
   d. Input point history
   e. Output point history
   f. Operator activity history
4. The system shall provide the capability to export printed information to files in the following formats, at a minimum:
   a. Microsoft Excel
   b. Microsoft Word
   c. ASCII text
5. The system shall provide the capability to schedule reports to generate automatically to a file or printer location.
6. The system shall provide an integral graphics application that can be used at any workstation within the network for real-time display of system activity.

7. The graphical application shall provide the following controls from within a map-like display, at a minimum:
    a. Display of real-time object's status
    b. Acknowledge alarm conditions
    c. Perform manual operations, such as lock and unlock on all monitoring control points
    d. Silence and acknowledge signals

2.9 DOOR CONFIGURATION

A. The system shall support the assignment of both door unlock times and door held open times. The door unlock times shall be used to unlock doors for a predefined time following a valid access or request to exit operation. The system shall allow up to 300 seconds of time for each doors unlock or door held open time.

B. Each door within the system shall have the ability of being automatically unlocked based on the time of day. Any access control door shall have the ability to generate a local alarm output in the event of the door being forced or left open. The report of these events shall be time definable.

C. Each card access door shall utilize a request to exit input to unlock the door without generating a forced door alarm condition. No additional hardware shall be required.

D. Additional doors, used as emergency exits only, shall have door forced open contacts and the system shall have the ability to override these alarms.

2.10 PHOTO IDENTIFICATION, BADGE GENERATION AND VIDEO VERIFICATION SUBSYSTEMS

A. General

1. The subsystems shall provide the following minimum set of functions:
    a. Creation of photo identification badges.
    b. Interfacing and loading of the system cardholder database.
    c. All necessary hardware and software for the integration of the manufacturer's system.
    d. Badge designer package.
    e. Instant capture, retrieval, updating and viewing of images and text data.
    f. Integrated loading of cardholder information from the cardholder database for badge creation.
    g. Video verification subsystem which would allow the card holder database image to be compared with on screen video images captured from the camera system and database text data.

2.11 ELECTRICAL POWER

A. Normal System Power Supply: 120 V 60 Hz from emergency power circuits.

B. Power Source Transfer: When normal power is interrupted, system is automatically switched to backup supply without degradation of critical system function or loss of signals or status data.
    1. Backup Source: Provide a minimum of 2-hour battery backup for all system components. A 2-hour backup power source shall also be provided for the power supplies that support the locking devices. Such batteries shall be an integral part of the power supplies that support the locking devices. Such batteries shall be an integral part of the power supplies.
    2. Annunciation: Switching of the system or any system component to backup power is indicated as a system alarm condition.

2.12 DOOR CONTACT INDICATORS

A. Contact indicators on doors where the door position switch in not provided by the door hardware contractor shall be button type magnetic reed switches with opposing magnet, and shall be per manufacturers recommendations for the type of door installed on. Use concealed types.

2.13 ELECTRIFIED LOCKS

A. All electrified locking devices shall be provided by the door hardware contractor. Provide sufficient coordination for correct termination and function with the access control system for all electrified hardware.

2.14 REQUEST TO EXIT DEVICES

A. Request to exit functions shall be provided by monitoring integral switches furnished in the locking hardware. Coordinate with door hardware contractor for cabling requirements.

2.15 POWER SUPPLIES

A. Where indicated in Section 87 10 00, the security contractor shall provide access control power supplies as per Hardware Set listings. Provide separate power supplies for access controllers and separate supplies for access locking devices. Coordinate with door hardware contractor on termination requirements.

2.16 WIRE AND CABLE

A. General: Stranded copper. Plenum rated. Size conductors as required by system manufacturer.

B. Comply with Division 16 Section “Wires and Cables” except as indicated.

C. Cable for Low-Voltage Control and Signal Circuits: Unshielded, twisted-pair cable, except where manufacturer recommends shielded cable.

2.17 RACEWAY

A. Comply with Division 16 Section “Raceways.”

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: Install system according to NFPA 70, applicable codes, and manufacturer’s printed instructions.

B. Wiring Method: Install all wiring in raceways, ¾ inch minimum. Conceal raceways except in unfinished indoor spaces. Multiple home runs may be contained in a single conduit of appropriate size. Conduit fill shall not exceed 40%.

C. Wiring Within Panels and Enclosures: Bundle, wrap, and train the conductors to terminal points with 6 inches of service loop, (12 inches maximum). Provide and use cable management hardware as required.

D. Number of Conductors: As recommended by system manufacturer for functions indicated.

E. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull and outlet boxes, terminal cabinets, and equipment enclosures.

F. Tighten connections to comply with tightening torques specified in UL Standard 486A.

G. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so media are identified and coordinated with system wiring diagrams.

H. Install power supplies and other auxiliary components for detection devices at the access control panel or at a data-gathering panel except as otherwise indicated. Do not install such items in the vicinity of the devices they serve, unless otherwise specified.

I. Extensive coordination with the associated door hardware contractors shall be required by the security contractor when connection to locking devices and installation of sensor equipment is called for.

3.2 GROUNDING

A. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and system pre-testing, testing, adjustment, and programming.

B. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

C. Pre-testing: Align and adjust the system and perform pre-testing of all components, wiring, and functions to verify conformance with specified requirements. Correct deficiencies by replacing malfunctioning or damaged items with new items. Retest until satisfactory performance and conditions are achieved.

D. Testing: Provide at least 10 days' notice of acceptance test performance schedule.

E. Operational Tests: Perform operational system tests to verify conformance with specifications. Test all modes of system operation and intrusion detection. Methodically test for false alarms in each zone of space intrusion detection devices by simulating activities outside indicated detection patterns.

F. Installer Start-up Responsibility: The Installer shall initiate system operation. Competent start-up personnel shall be enlisted by the Installer on each consecutive working day until the system is fully functional. Upon reoccurring technical problems, the Installer shall supply factory direct Manufacturer's support in the form of factory technical representation and/or diagnostic equipment until the resolution of those defined problems.

3.4 ADJUSTMENT

A. Occupancy Adjustments: When requested within 1 year of date of substantial completion, provide on-site assistance in adjusting and reprograming to suit actual occupied conditions. Provide up to 3 visits to the site for this purpose without additional cost. All initial and subsequent system programming shall become the property of the Owner.

3.5 COMMISSIONING

A. Train Owner's operating personnel in the programming and operation of the system. Train Owner's maintenance personnel in the procedures and schedules involved in preventive maintenance and in

programming, operating, adjusting, troubleshooting, and servicing of the system. Provide a minimum of 6 hours training.

B. Schedule training with advance notice of at least 7 days.

END OF SECTION 281000

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SECTION 282310 - VIDEO MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes a Video Management System (VMS) consisting of computer hardware, software, and associated licensing and equipment for monitoring, recording, and managing surveillance camera system images and data.

B. The VMS system shall be used to view live and recorded video from IP cameras connected to a common local and/or wide area network (LAN/WAN).

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including:

1. Related Specification Sections:

a. Section 282329 – Video Surveillance Remote Devices and Sensors

1.3 DEFINITIONS

A. API: Application Programming Interface
B. AVI: Audio Video Interleave
C. CE: European Union Conformity
D. CD: Compact Disk
E. CPU: Central Processing Unit
F. DVD: Digital Video Disk
G. DVR: Digital Video Recorder
H. FCC: Federal Communications Commission
I. FoV: Field-of-View
J. GB: Gigabyte
K. Gb: Gigabit
L. HMAC: Hash Message Authentication Code
M. H.264, H.265: Video Compression Standards
N. IP: Internet Protocol
O. iSCSI: Internet Small Computer System Interface
P. JPEG: Joint Photographic Experts Group
Q. LAN: Local Area Network
R. LCD: Liquid Crystal Display
S. MAC: Media Access Control
T. MB: Megabyte
U. Mb: Megabit
V. MJPEG: Motion JPEG
W. NECA: National Electric Code Association
X. NFPA: National Fire Protection Association
Y. NIC: Network Interface Card
Z. NVR: Network Video Recorder
AA. OS: Operating System
BB. OVID: Open Video Integration Driver
CC. POS: Point-of-Sale

DD. PS: Program Stream
EE. PTZ: Pan-Tilt-Zoom
FF. RAM: Random Access Memory
GG. SMS: Security Management System
HH. SUSP: Software Upgrade and Support Plan
II. TB: Terabyte
JJ. TCP: Transmission control protocol - connects hosts on the Internet
KK. UI: User Interface
LL. UPS: Uninterruptible Power Supply
MM. USB: Universal Serial Bus
NN. VMS: Video Management System
OO. WAN: Wide Area Network

1.4 PERFORMANCE REQUIREMENTS

A. The VMS system shall be certified by to meet the following standards:

1. System shall be RoHS (Restriction of Hazardous Substances) compliant and meet proposed amendments to the reduction of toxic substances in manufacturing as stated in the Environmental Design of Electrical Equipment Act (EDEE)

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

3. Installation shall comply with NECA 1-2010 “Standard Practice of Good Workmanship in Electrical Construction”

4. Installation shall comply with NEC/NFPA 70E “Standard for Electrical Safety in the Workplace”

5. Electronic data exchange between Video Surveillance System with an Access Control System shall comply with SIA TVAC

6. Installation shall comply with FCC CFR 47 Part 15 Class A "Telecommunications, Radio Frequency, Digital Device Emission

7. Installation shall comply with federal, state, and local codes and authorities having jurisdiction (AHJ)

1.5 SUBMITTALS

A. Product Data: Provide details and technical specifications for each product indicated. Include physical dimensions, features, performance, electrical characteristics, ratings, software versions, and operating system details.

B. Shop Drawings: Include system line diagrams, equipment locations, installation details, and system integration plans

1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types, quantities, and sizes

2. Data Calculations: Provide VMS bandwidth and storage calculations meeting the minimum project requirements as described herein

3. Wiring Diagrams: For power and data wiring

C. Equipment and Software List: Include every piece of equipment and software by product/model name and/or number, manufacturer, location, and date of original installation. If factory and/or bench testing regimens are required by the project plan, add pretesting record of each piece of equipment and software, listing name of person testing, date of test, and adjustments made.

1.6 INFORMATIONAL SUBMITTALS

A. Warranty: Software support and warranty information for all components, including Service Level Agreement (SLA) details, and duration of agreement from date of system acceptance by Owner

B. Current Integrator Certification Letter for Manufacturer of submitted equipment

C. Current Training Certificates (listing expiration dates) for four (4) technicians from the supporting office for the Manufacturer of the submitted equipment.

1.7 CONTRACTOR REQUIREMENTS

A. The Contractor shall have a supporting office within fifty (50) miles of the project location.

B. Certifications: Four (4) technicians from the supporting office shall hold current certifications with equipment.

C. On-site Contractor personnel shall hold all required local, state, and federal licenses.

D. On-site Contractor personnel shall hold current certifications with the manufacturer.

E. The Contractor shall provide three (3) references for completed projects of similar scope.

F. The Contractor shall provide a 1-year warranty on labor from date of Owner Acceptance

1.8 CLOSEOUT SUBMITTALS

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

1. Extra Materials:
   a. Return all left-over (unused) product and materials to the Owner.

2. Applicable operating system, database, client, and application software on portable storage media

3. Full System Backup as of closeout date on portable storage media

4. Submit one (1) printed and one (1) electronic copy of project binder in final form. This copy shall contain as a minimum:

   a. Table of Contents for each element

   b. Contractor information - names phone numbers, and email for sales, technical support, and consumables reordering

   c. Lists of spare parts and replacement components recommended to be stored at the site for ready access

d. Datasheets for all equipment

e. Operation and maintenance manuals for all equipment

f. Operation and maintenance procedures not covered in manufacture’s manuals

1.9 QUALITY ASSURANCE

A. Installation shall comply with federal, state, and local codes and authorities having jurisdiction (AHJ).

B. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. All software and hardware shall be programmed and installed in accordance with manufacturer’s specifications.

D. All equipment shall be new, in current production, and the standard products of a manufacturer of ESS equipment.

E. The contractor shall review drawings and specifications.

F. Software integration between all integrated systems shall be tested and certified for interoperability by the manufacturer of each system.

1.10 PERMITS

A. All permits required for the specified performance and completion of the work shall be secured by the Contractor.

1.11 PROJECT CONDITIONS

A. Environmental Conditions: System components shall withstand the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior Environmentally Controlled Space: Rated for continuous operation in ambient temperatures of 32° to 95° F (0° to 35° C) dry bulb and a relative humidity of 20 to 80 percent, noncondensing.

1.12 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to service, repair or replace system components as needed for proper system operation as specified herein.

B. Warranty Period:

1. A 3-year warranty on hardware and software.

2. VMS Virtual Machine: A 3-year warranty on software.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Hikvision

2.2 SYSTEM REQUIREMENTS

A. The VMS Video Management System ("VMS") shall be a system for comprehensive management of live and recorded video, and associated data.

B. The VMS system is a browser-based video management application deployed on a purpose built appliance. The VMS system shall be deployable as either a physical or a virtual appliance. The VMS system shall be capable of supporting an unlimited number of IP cameras and an unlimited amount of video storage across multiple physical or virtual appliances. The VMS system is available as a stand-alone video management system and as a unified security management system where video management is tightly integrated with an access control system. Real-time video monitoring and recorded video playback shall be accessible through the VMS browser-based application.

C. The VMS software shall be a browser-based application, allowing for monitoring of live and recorded video as well as camera configuration, archive configuration, and event configuration. VMS live and recorded video shall also be accessible via a client application which can connect to one or more VMS appliances. Multiple workstations shall be capable of simultaneously viewing live and/or recorded video from one or more VMS servers. Multiple VMS servers shall also be capable of simultaneously providing live and/or recorded video to one or more client workstations.

D. The VMS system shall provide a minimum of thirty (30) days of recorded video for all attached cameras and encoders.

2.3 GENERAL FUNCTIONALITY

A. The VMS system shall be available as either a physical or a virtual appliance.

B. The VMS system shall support monitoring and recording of video and data from IP cameras and encoding devices in real time over local and wide area networks.

C. The VMS system shall be licensed on a per camera basis.

D. The VMS system shall support administration via a browser-based application.

E. The VMS system shall support data integration with access control systems.

F. The VMS system shall support event-based email and text (SMS) notifications.

G. The VMS system shall offer an open architecture supporting IP cameras and encoders using both standard protocols, as well as camera specific interfaces for certain camera families.

H. The VMS system shall be configurable for recording based on video motion detection, so that video shall be recorded when the camera detects motion within user-defined regions of interest within each camera's Field-of-View (FoV). The system shall also record pre-event and post-event video based on user-defined operating parameters.

I. The VMS system shall be configurable for recording based on alarm event, so that video shall be recorded when the VMS receives a notification of an event with a record video action from the integrated access control system or triggered

by the camera. The system shall also record pre-event and post-event video based on user-defined operating parameters.

J. The VMS system shall not require that the manufacturer be contacted for a camera on the system to be replaced. The VMS system shall allow users to replace cameras without the need for individual camera license keys.

K. The VMS system shall support the use of panoramic lenses.

L. The VMS system shall support a system health event to be triggered when a VMS error condition, such as a failed media drive, is detected by the VMS system.

M. The VMS system shall support a camera health alert to be activated when a camera error condition, such as an offline camera, is detected by the VMS system.

N. The VMS system shall support direct communication to the workstation application. This shall allow for application to be recognized in the VMS system, providing available cameras and available views which can be called up in the user interface via VMS events.

O. The VMS system shall support the ability to search for multiple cameras on the network via a camera scan function. The camera scan function shall return all IP cameras accessible on the network and allow for rapid configuration.

P. The VMS system shall support the ability to monitor and sort the status of the cameras to verify that a camera is connected to the VMS system and that the camera is online and recording.

Q. The VMS system shall allow for camera searching by camera name.

R. The VMS system shall support cameras from multiple manufacturers.

S. User administration

1. Permissions

a. Authenticate the user's permission level by
1) Combination of user name and password

T. Video Streaming

1. Video formats supported: H.264, H.265

2. The VMS system shall allow for continuous video recording, as well as video recording based on motion or alarm. An administrator shall be able to schedule continuous recording, motion-activated recording, and alarm based recording.

3. Streams shall be individually configurable for frame rates, resolutions, and recording schedules.

4. Multi-streaming – The VMS system shall allow the setting of multiple, independent video streams from an IP camera, when supported by the camera model, each configurable for frame rate, resolution, and quality level.

5. The VMS system shall allow for the adjustment of brightness, contrast, saturation, sharpness, and hue per camera, when supported by the camera manufacturer.

6. The VMS system shall support the overlay of camera information on the video stream, including name, time, and date. The camera information shall be adjustable in regard to position, size, and color.

7. The VMS system shall support the ability to configure camera Pan, Tilt, and Zoom preset positions.

8. The VMS system shall support ONVIF Profile T Compliance for IP-based video systems. ONVIF Profile T supports video streaming features such as H.264 and H.265 encoded formats, image settings, metadata streaming, PTZ controls, and camera-based motion detection.

9. The VMS system shall support HTTPS secure communication between the camera and the VMS video recorder.

U. Recording

1. The VMS system shall support continuous, uninterrupted, and unattended recording of all video transmitted to the VMS, including during times of administration and configuration of any feature.

2. The VMS system shall support recording video based on metadata generated by an edge network device and included in the video stream sent to the VMS server.

3. The VMS system shall support the configuration of each video input's recording time by day and by minute, to further allow the user to schedule when to record on motion and when to record continuously.

4. The VMS system shall support video recording based on access control events and activity.

5. The VMS system shall support recording video based on the following classifications:

   a. Continuous Recording (all video, all the time)

   b. Video associated with motion events as detected by the camera

   c. Video associated with triggered alarms as configured with an integrated access control solution (as supported by the manufacturer)

   d. For specific camera manufacturers, video associated with camera-based analytics events as detected by the camera while the analytics events are configured on the video recorder or integrated access control solution (as supported by the manufacturer).

6. The VMS system shall support the configuration of unique weekly recording schedules per camera and camera stream.

7. The VMS system shall support a graphical representation of drive status for associated RAID-based storage.

8. The VMS system shall support the ability to set a local retention policy, which limits the number of days local recordings will be retained. Recordings are deleted based on the set retention period or as space allows.

9. Storage Types:

   a. The VMS system shall support local HDD disk storage.

   b. The VMS system shall support up to 288TB of internal RAID 5, RAID 6, or JBOD storage configurations per appliance and shall not require operating system resources to manage storage.

2.4 HARDWARE

A. The VMS system shall support a solid-state drive to store the application and configuration data. This SSD shall not be used to store video data.

B. Events in the access control system shall have the capability to initiate video recording. Video motion detection, camera status messages, and camera based analytics for specific models, from VMS shall have the capability to initiate alarms.

C. VMS is a video management appliance that is designed to be integrated with a Security Management System (SMS). The integration provides a single user interface for the SMS access control and monitoring capabilities and the VMS video surveillance and forensics capabilities.

D. Multiple VMS appliances can be connected to a Security Management System.

E. VMS Hardware Specifications:

1. Video Management

a.	Max IP Camera Streams	64
b.	IP Camera Resolution	IP camera dependent
c.	IP Camera Frame Rate	IP camera dependent
d.	Compression type	H.264, H.265 (camera dependent)

2. Platform

a.	Max Storage (internal)	16TB, 32TB, or 48TB (4 hard drive bays) (4TB, 8TB, or 12TB removable drives)
b.	Storage Configuration	RAID 5 or RAID 6
c.	Sustained Hard Drive Throughput	400Mbps
d.	Certifications / Compliances	UL, CE, FCC, RoHS
e.	Warranty	3 Years (hardware and software)
f.	Operation Temperature	50° - 95°F (10° - 35°C)
g.	Storage Temperature	-40° - 158°F (-40° - 70°C)
h.	Operating Environment	Humidity 85%, non-condensing
i.	AC Input	100 - 240 VAC, 50/60 Hz, 6A/3A
j.	MTBF	45,600 hours
k.	BTU/h	1,075

3. Minimum Client Requirements

a.	Operating System	Microsoft Windows 7 Microsoft Windows 10 Mac OS High Sierra Mac OS X Yosemite (10) Mac OS X El Capitan (11)Browser Internet Explorer Version 11 Chrome 79 Firefox 72 Safari 8, 9
b.	Processor	Intel Core i3
c.	RAM	8GB
d.	Hard Drive	100GB

2.5 VMS VIRTUAL MACHINE

A. VMS Virtual Machine shall be deployable as a virtual machine based software solution supporting up to 128 IP camera streams.

B. VMS Virtual Machine shall support:

1. Deployment as a stand-alone system

2. Real-time video monitoring and recorded video playback integration with a manufacturer approved access control platform

3. Real-time video monitoring and recorded video playback integration with a manufacturer client solution options ranging from single displays to expansive video walls

4. Real-time video monitoring and recorded video playback integration with system user interface

5. Communication cloud service for licensing

C. VMS Virtual Machine hardware requirements

1. Support for up to 128 video streams

a. CPU: Intel Xeon Quad Core (3.1 GHz)
b. Memory: 16GB
c. Storage: 8TB minimum
d. Server Host: VMWare EXSi v6.5
e. Operating System: 64-bit Linux Ubuntu 18.04.3 LTS
f. Network Interface: 2 x 1GB Ethernet ports minimum

2.6 MOBILE APPLICATION

A. A mobile application shall be available from the Manufacturer.

B. The Mobile Application shall support remote view of live and recorded video through the VMS system.

C. The Mobile Application shall support monitoring of events.

D. The Mobile Application shall support the viewing of video and access control data.

E. The Mobile Application shall be available for both iOS and Android operating systems

2.7 SECURITY MANAGEMENT

A. The Security Management System (SMS) shall provide a single client management application for the security system.

B. The Client Management application shall be the primary interface for monitoring live and recorded video stored on the VMS

C. Client Management application software shall be available for installation as a native client.

1. Supported Operating Systems

a. Windows 10
b. Mac OS High Sierra and later

D. There shall be no licensing fees associated with the number of concurrent Client Management applications connected to one or more VMS systems.

E. The solution shall be based on a software package for comprehensive management of live and recorded video, real time access control and alarm management-and-notifications combined with digital signage management for public safety announcements.

F. Client Management application shall be able to interface and control any other SMS hardware appliances available on the network

1. All configuration and setup shall be available through a remote connection and shall not require direct access to the appliance or software

2. In the event of power loss and restoral, the Client Management application appliance shall restart and display preprogrammed content in less than 30 seconds.

G. CLIENT MANAGEMENT SYSTEM FUNCTIONALITY

1. The Client Management solution shall provide the ability to operate in a secure access mode that requires the application to use existing credentials from the VMS and shall not require duplication of users

   a. The Client Management application software shall have the ability to manage login credentials and shall be able to be managed as a single credential over the video, access-control and Client Management application client operations

   b. The Client Management application software shall provide a standalone mode with no requirement to authenticate with the internet gateway and shall provide the ability to add network video recorders and access controllers with local credentials

2. Client Management application shall provide the ability to be set as an active client for video, access control and event management or as a standalone remote managed screen for video and public safety notifications

3. Client Management application shall provide live real-time monitoring of video from IP cameras and encoding devices and data from access-control devices in real time over local and wide area networks

4. Client Management application shall provide live real-time monitoring of access-control activity data and video verification in real time over local and wide area networks

5. Client Management application shall provide the ability to show video based on access control activity, live or recorded, and the option to view image from the card holder database based on the access control activity

6. Client Management application software shall allow remote access to live and recorded video, live and collected access control activity including access from mobile devices

H. LAYOUTS - CELLS

1. The client management system shall support multiple layouts:

   a. Each layout shall support:
      1) Live Video
      2) Recorded Video
      3) Access Control Activity - Access-control, SMS data and/or card holder image can be set with filters for a specific portal and specific activity:
         a) Access Control only
         b) Alarms and Events
         c) Access Granted only
         d) Access Denied only
         e) Threat level
         f) System Administration
      4) Cardholder Images
      5) Alarm Events
      6) Time and Date

2. Client Management application shall provide various default layouts to fit common video and access-control operations

3. Client Management application shall support custom layouts

4. Client Management application shall support switching to a saved layout based on:

    a. Alarm Event Popups

    b. Operator drag-and-drop actions

    c. Receiving an Security Management System message

I. LIVE VIDEO

1. Client Management application shall support access to all operator authorized video streams

2. Video stream lists shall be available as:

    a. Recorder list – each Network Video Recorder with associated cameras

    b. Camera list – all cameras sorted alphabetically (ascending or descending)

3. Client Management application shall support acquiring and saving a snapshot from a live stream, instant replay stream, or event video playback stream

4. Client Management application shall support instant replay

J. FORENSIC VIDEO

1. Client Management application shall support video search by:

    a. Date and time

    b. Thumbnail video

    c. Event, alarm, or access control data. Ability to search video tagged with metadata obtained by object detection.

2. Client Management application shall support a folder system

    a. The folder system shall support storage of exported video clips and image collections

    b. The folder system shall support the ability to manage all content in a folder structure

2.8 EXAMINATION

A. Examine cable pathways including conduit, raceways, cable trays, and other pathway elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine rough-in for control cable and conduit systems to controllers, card readers, and other system components to verify conduit and back-box locations prior to installation of system devices

C. Examine available network capacity and support infrastructure. Consult with network administrator for compliance with network standards and capacity

D. Examine install location for compliance with space allocations, installation tolerance, hazards to safe system operation, and other conditions affecting installation

E. Examine roughing-in for LAN, WAN, and IP network before device installation

2.9 PREPARATION

A. Prior to beginning system programming, prepare detailed project planning forms for programming and configuration of the system. Fill in all data available from project plans and specifications and publish as project planning documents for review and approval. These may include (but are not limited to):
1. Define user (operator) types
2. Define camera naming schema
3. Determine storage requirements
4. Determine FPS requirements
5. Determine motion recording
6. Define event programming
7. Develop matrix layouts
8. Prepare a project specific plan for system testing, startup, and demonstration
9. Develop cable and asset-management system labeling plan

B. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final programming and configuration documents. Use final documents to program and configure software.

2.10 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction".

B. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

C. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 performance of completed and linked signal paths, end to end.

D. Junction boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with tamper resistant fasteners and/or tamper detection switches. In addition, hinged enclosure doors shall be equipped with locking hardware. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

2.11 IDENTIFICATION

A. Label, in plain English, each end of each cable, field panel, patch panel, network switch, or cabinet

1. Each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the device as shown

2.12 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform tests for the complete and proper operation of systems involved

B. Assign the software license(s) to Owner

C. All default password shall be changed to those selected by the owner

1. The contractor shall retain no records of passwords for the project

2.13 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Inspection: Confirm that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

2. Pretesting: Configure and pretest VMS components, wiring, and functions to confirm that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

a. Prepare equipment list

b. Confirm operation of all camera streams and check data storage configuration.

c. Confirm operation of all third-party integrated components and systems

d. Set and name all camera streams and preset positions; consult Owner's personnel.

e. Confirm operation of monitoring equipment.

3. Operational Tests: Perform operational system tests to confirm that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. The system is considered defective and the project incomplete if it does not pass tests and inspections

D. Prepare test and inspection reports

2.14 ADJUSTMENTS

A. Occupancy Adjustments: When requested within 30 days of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections

2. Check proper operation of cameras streams and storage configuration

3. Confirm system configuration and adjust settings needed

4. Recommend changes to the system to improve Owner's use

5. Provide a written report of adjustments and recommendations

2.15 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment

B. Develop and provide separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.

2. Security monitoring personnel

2.16 MAINTENANCE

A. The Contractor shall offer a ongoing maintenance agreement

1. The Contactor shall offer the agreement in 1-year, 3-year, and 5-year increments.

2. As part of the agreement, access to software patches and software upgrades shall be available.

END OF SECTION 282310

SECTION 282329 – VIDEO SURVEILLANCE REMOTE DEVICES AND SENSORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes multi-directional (omnidirectional) cameras with a 360 degree field of view in vandal proof dome housing.

B. Section includes interior IP dome cameras

C. Section includes exterior IP dome camera

D. Section includes IP video cameras, with multi-streaming (H.265, H.264 and MJPEG) capability in a dome housing with integral IR illuminator.

E. Related Requirements

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including:

1.) Related Specification Sections:

a.) Section 283000 – Security Detection, Alarm, and Monitoring

b.) Section 282310 – Video Management System

1.03 DEFINITIONS

A. Abbreviations

1. AGC - Automatic Gain Control
2. AWB - Automatic White Balance
3. BLC – Back light compression
4. CBR – Constant Bit Rate
5. CVBS – Color, Video, Blanking, Sync
6. DHCP - Dynamic Host Configuration Protocol
7. DNR – Digital Noise Reduction
8. DNS - Domain Name Server
9. DDNS – Dynamic Domain Name Server
10. fps - frames per second
11. FTP - File Transfer Protocol
12. GOV – Group of Video
13. GUI – Graphical User Interface
14. HD – High Definition
15. HTTP - Hypertext Transfer Protocol
16. IP - Internet Protocol
17. JPEG - Joint Photographic Experts Group
18. MJPEG - Motion JPEG
19. MP - Megapixel
20. MPEG - Moving Pictures Experts Group

21. NAS – Network Attached Storage
22. NTP - Network Time Protocol
23. PoE - Power over Ethernet
24. RTP - Real-Time Transport Protocol
25. RTCP – Real-Time Control Protocol
26. RTSP - Real-Time Streaming Protocol
27. SDK – Software Development Kit
28. SMTP - Simple Mail Transfer Protocol
29. SNMP – Simple Network Management Protocol
30. SSL – Secure Sockets Layer
31. TCP - Transmission Control Protocol
32. UDP - User Datagram Protocol
33. UPnP – Universal Plug and Play
34. VBR – Variable Bit Rate
35. VMS - Video Management System
36. WDR – Wide Dynamic Range
37. LDC – Lens Distortion Correction

B. Reference Standards
   1. Network - IEEE
      a. 802.3 Ethernet Standards
      b. 802.1x Port-based Network Access Control
   2. Video
      a. ISO / IEC 23008-2:2013, MPEG-H Part2 (ITU H.265, HEVC)
      b. ISO / IEC 14496–10, MPEG-4 Part 10 (ITU H.264)
      c. ISO / IEC 10918 – JPEG
      d. ONVIF – Profiles S
   3. Emissions
      a. FCC-47 CFR Part 15 Subpart B Class B
      b. CE EN 55022:2010
   4. Immunity - CE
      a. EN 50130-4:2011
      b. EN 61000-3-3:2014
      c. EN 61000-4-2:2009
      d. EN 61000-4-3:2006+A2:2010
      e. EN 61000-4-4:2012
      f. EN 61000-4-5:2014
      g. EN 61000-4-6:2009
   5. Safety
      a. UL listed
      b. CE EN 50581:2012 (hazardous substances)

6. Ingress Protection and Vandal Resistance
    a. ANSI / IEC60529 – Degrees of protection Provided by Enclosures : IP67
    b. IEC EN 62262 - Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts : IK10
    c. IEC 60068-2-75 : IK10

C. Definitions
1. GOV (Group of Video object planes) - A set of video frames for H.264 and H.265 compression, indicating a collection of frames from the initial I-Frame (key frame) to the next I-Frame. GOV consists of 2 kinds of frames: I-Frame and P-Frame.
2. WiseStream – Smart Codec that controls quantization parameter in H.265 and H.264 to efficiently manage bitrate of the video stream and reduce the storage required.
3. Dynamic GOV – Dynamic assignment of GOV length based on the complexity of the scene to efficiently manage bitrate of the video stream and reduce the storage required.
4. Multi-exposure wide dynamic range - Operation which automatically adjusts shutter speed to provide a wide range between dark and light areas visible at the same time, preventing backlighting issues. Long exposure is used for bright areas and a short exposure is used in dark areas.
5. Dynamic fps – Dynamic assignment of fps (frames per seconds) based on the movement of object(s) in the scene to efficiently manage bitrate of the video stream and reduce the storage required.

1.04 SUBMITTALS

A. Product Data: Manufacturer's data, user and installation manuals for all equipment and software programs including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

B. Shop Drawings: Shop drawings shall provide details of proposed system and the work to be provided. Include point-to-point drawings of systems and wiring diagrams of individual devices.
1. Detailed wiring diagrams and system description.
2. System device locations on architectural floor plans.
3. Full Schematic of system, including wiring information for all devices.

C. Documentation to be submitted by the Contractor upon completion of system installation:
1. "As-builts": Upon completion of installation, the Contractor shall prepare "as-built" drawings of the system. These "As-builts" shall be 30 inches by 42 inches (76 cm by 107 cm) format mylar reproducible drawings of each floor plan indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag.
    a. Additionally, final point-to-point wiring diagrams of each type of device (on 30 inches by 42 inches (76 cm by 107 cm) format) shall be included in the "as-builts."
    b. As-builts" shall be submitted to the Owner for approval prior to the system acceptance walk-through.
2. Operation and maintenance manuals: Three sets of operating manuals shall be provided explaining the operation and maintenance of the system.
3. Parts list.

1.05 QUALIFICATIONS

A. Manufacturer shall have a minimum of five years' experience in producing IP video equipment.

B. The Contractor shall have a supporting office within fifty (50) miles of the project location.

C. Certifications: Four (4) technicians from the supporting office shall hold current certifications with LenelS2

D. On-site Contractor personnel shall hold all required local, state, and federal licenses.

E. Installers shall be trained and authorized by the Manufacturer to install, integrate, test, and commission the system.

F. The Contractor shall provide a 1-year warranty on labor from date of Owner Acceptance.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver the camera in the manufacturer's original, unopened, undamaged container with identification labels intact.

B. Store the camera in a temperature environment indicated in 2.04 Detailed Specification, protected from mechanical and environmental conditions as designated by the manufacturer.

1.07 WARRANTY, LICENSING AND SUPPORT

A. Manufacturer shall provide a limited 3-year warranty for the product to be free of defects in material and workmanship.

B. Manufacturer shall provide embedded camera video analytics free of license charges.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of design: Hanwha Techwin

B. Approved Alternates: Subject to compliance with requirements. Provide prebid submittals for review and approval.

2.02 MULTI-SENSOR 360 CAMERA

A. The camera shall provide 360-degree field of view and produce video in quad view mode. It shall also provide digital PTZ along with automated video analytics to allow users to efficiently monitor large visual fields with capability to focus on certain areas when suspicious activity is observed.

B. Model: 8MP MULTI-SENSOR 360 CAMERA

1. Imager

a. Sensor: 1/2.8" 2.38M CMOS (The camera includes four sensors.)

1.) pixels per sensor: 1945 (H) x 1109 (V) total; 1945 (H) x 1097 (V) effective

2.) scanning : progressive

b. Minimum illumination

1.) Color mode: 0.015Lux (F1.4, 1/30 sec)

2.) Black & white mode: 0.0015Lux (F1.4, 1/30 sec)

c. Lens: 2.8mm ~ 12mm (4.3x) motorized varifocal

1.) Max. Aperture Ratio F1.4(Wide) ~ F3.6(Tele)

2.) Angle of view: H : 119.5˚(Wide) ~ 27.9˚(Tele), V : 62.8˚(Wide) ~ 15.7˚(Tele), D : 142.1˚(Wide) ~ 32.0˚(Tele) (for each lens)

3.) Min. Object Distance 0.5 m (1.64ft)

4.) Focus Control Simple focus (Motorized V/F)
Manual - Remote control via network (Manual, Simple focus)

5.) Lens Type DC Auto Iris, P-Iris

6.) Mount Type Board Type

d. Pan/Tilt/Rotate

1.) Pan ±15˚

2.) Tilt 10˚ ~ 41˚, 10˚ ~ 90˚ (CH2/Center)

3.) Zoom ±90˚

2. Electrical

a. Power
   1.) Input Voltage / Current PoE+, 12 DC
   2.) Power Consumption:
      a.) 12V DC Max. 21.6W
      b.) PoE Max. 25.5W

3. Mechanical And Environmental
   a. Material:
      1.) Housing: Aluminum
   b. Dimensions (W x H): 315.0 x 152 mm (12.40 in. x 5.98 in.)
   c. Weight 4.83kg (10.65 lb.)
   d. Temperature:
      1.) Operating: -40° C to 55° C (40° F to 131° F)
      2.) Storage: -50° C to 60° C (-58° F to 140° F)
   e. Humidity: 0 - 90%, non-condensing
   f. Environmental Rating:
      1.) Mechanical (Vandal) Protection IK10
      2.) Ingress Protection IP66

C. Model: 20MP MULTI-SENSOR 360 CAMERA
   1. Imager
      a. Sensor: 1/1.8" 6M CMOS (The camera includes four sensors.)
         1.) pixels per sensor: 3096 (H) x 2094 (V) 6M x 4 total
            2616 (H) x 1976 (V) 5M x 4 effective
         2.) scanning: progressive
      b. Minimum illumination
         1.) Color mode: 0.07Lux (F1.2, 1/30 sec)
         2.) Black & white mode: 0.007Lux (F1.2, 1/30 sec)
      c. Lens: 3.6mm ~ 9.4mm (2.6x) motorized varifocal
         1.) Max. Aperture Ratio F1.2
         2.) Angle of view: H : 102.5˚(Wide) ~ 38.7˚(Tele), V : 74.2˚(Wide) ~ 29.0˚(Tele),
            D : 135.5˚(Wide) ~ 48.6˚(Tele)
         3.) Min. Object Distance 0.5 m (1.64ft)
         4.) Focus Control Simple focus (Motorized V/F)
            Manual - Remote control via network (Manual, Simple focus)
         5.) Lens Type DC Auto Iris, P-Iris
         6.) Mount Type Board Type
      d. Pan/Tilt/Rotate
         1.) Pan ±15˚
         2.) Tilt 10˚ ~ 41˚, 10˚ ~ 90˚ (CH2/Center)
         3.) Zoom ±90˚
   2. Electrical

a. Power
1.) Input Voltage / Current HPoE, 12 DC
2.) Power Consumption:
a.) 12V DC Max. 28.8W
b.) HPoE Max. 33.6W

3. Mechanical And Environmental
a. Material:
1.) Housing: Aluminum
b. Dimensions (W x H): 315.0 x 152 mm (12.40 in. x 5.98 in.)
c. Weight 4.89kg (10.78 lb.)
d. Temperature:
1.) Operating: -40° C to 55° C (40° F to 131° F)
2.) Storage: -50° C to 60° C (-58° F to 140° F)
e. Humidity: 0 - 90%, non-condensing
f. Environmental Rating:
1.) Mechanical (Vandal) Protection IK10
2.) Ingress Protection IP66

2.03 INTERIOR DOME CAMERA

A. MODEL: 2 MP Network IR Dome Camera with Motorized Varifocal Lens

1. Imager
a. Sensor: 1/2.8" 2 MP CMOS
1.) pixels per sensor: 1920 (H) x 1080(V) total; 1920 (H) x 1080 (V) effective
2.) scanning: progressive
b. Minimum illumination
1.) Color mode: 0.095Lux (30IRE)
2.) Black & white mode: 0Lux (IR LED on)
c. Lens: 3.2 ~ 10 mm (3.1x) motorized V/F
1.) Max. Aperture Ratio F1.6(Wide)~F2.9(Tele)
2.) Angle of view: H: 109.0° ~ 33.2° / V: 57.4° ~ 18.7 / D: 132.0~ 38.0°
3.) Focus Control simple focus
4.) Lens Type DC auto iris
5.) Mount Type Board Type
2. Pan/Tilt/Rotate Range 0˚~350˚ / 0˚~67˚ / 0˚~355˚
3. IR Viewable Length: 20 m (65.62ft)
4. Electrical
a. Power
1.) Input Voltage / Current PoE (IEEE802.3af, Class3), 12V DC
2.) Power Consumption: <7.7 W (PoE), <6.5 W (12V DC)
5. Mechanical And Environmental

a. Material:
1.) Housing: Plastic
b. Dimensions (W x H): Ø119.8 x 98.8mm (Ø4.72 x 3.89"),
c. Weight 320g (0.705 lb.)
d. Temperature:
1.) Operating: -10° C to 55° C (14° F to 131° F)
2.) Storage: -30° C to 60° C (-22° F to 140° F)
e. Humidity: 0 - 90%, non-condensing

B. MODEL: 5 MP Network IR Dome Camera with Motorized Varifocal Lens
1. Imager
a. Sensor: 1/2.8" 5 MP CMOS
1.) pixels per sensor: 2,704(H)x2,104(V), Effective: 2,592(H) x 1,944(V)
2.) scanning: progressive
b. Minimum illumination
1.) Color mode: 0.15Lux (F1.6, 1/30sec)
2.) Black & white mode: 0Lux (IR LED on)
c. Lens: 3.2 ~ 10 mm (3.1x) motorized V/F
a. Max. Aperture Ratio F1.6(Wide)~F2.9(Tele)
b. Angle of view: [Wide] H: 100.3˚, V: 72.3°, D: 133.1°
[Tele] H: 31.2˚, V: 23.5°, D: 38.8°
c. Focus Control simple focus
d. Lens Type DC auto iris
2. Pan/Tilt/Rotate Range 0˚~350˚ / 0˚~67˚ / 0˚~355˚
3. IR Viewable Length: 20 m (65.62ft)
4. Electrical
a. Power
1.) Input Voltage / Current PoE (IEEE802.3af, Class3)
2.) Power Consumption: Max 8.9W, typical 6.6W
5. Mechanical And Environmental
a. Material:
1.) Housing: Plastic
b. Dimensions (W x H): Ø120.3 x 102.0mm (Ø 4.72" x 3.89")
c. Weight 430g (0.95 lb)
d. Temperature:
1.) Operating: -10° C to 50° C (14° F to 122° F)
2.) Storage: -30° C to 60° C (-22° F to 140° F)
e. Humidity: 0 - 90%, non-condensing

2.04 EXTERIOR DOME CAMERA

A. MODEL: 2 MP Network Exterior IR Dome Camera with Motorized Varifocal Lens

1. Imager
    a. Sensor: 1/2.8" 2 MP CMOS
        1.) pixels per sensor: 1920 (H) x 1080(V) total; 1920 (H) x 1080 (V) effective
        2.) scanning: progressive
    b. Minimum illumination
        1.) Color mode: 0.095Lux (30IRE)
        2.) Black & white mode: 0Lux (IR LED on)
    c. Lens: 3.2 ~ 10 mm (3.1x) motorized V/F
        1.) Max. Aperture Ratio F1.6(Wide)~F2.9(Tele)
        2.) Angle of view: H: 109.0° ~ 33.2° / V: 57.4° ~ 18.7 / D: 132.0~ 38.0°
        3.) Focus Control simple focus
        4.) Lens Type DC auto iris
        5.) Mount Type Board Type
2. Pan/Tilt/Rotate Range 0˚~350˚ / 0˚~67˚ / 0˚~355˚
3. IR Viewable Length: 30 m (98.43ft)
4. Electrical
    a. Power
        1.) Input Voltage / Current PoE (IEEE802.3af, Class3), 12V DC
        2.) Power Consumption: <7.7 W (PoE), <6.5 W (12V DC)
5. Mechanical And Environmental
    a. Material:
        1.) Housing: Aluminum
    b. Dimensions (W x H): Ø137.0 x 106.1mm (Ø5.39 x 4.18")
    c. Weight 710g (1.565 lb.)
    d. Temperature:
        1.) Operating: -30° C to 55° C (-22° F to 131° F)
        2.) Storage: -30° C to 60° C (-22° F to 140° F)
    e. Environmental Rating:
        1.) Ingress Protection IP66
        2.) Mechanical(Vandal) Protection IK10
    f. Humidity: 0 - 90%, non-condensing

B. MODEL: 5 MP Network Exterior IR Dome Camera with Motorized Varifocal Lens
1. Imager
    a. Sensor: 1/2.8" 5 MP CMOS
        1.) pixels per sensor: 2,704(H)x2,104(V), Effective: 2,592(H) x 1,944(V)
        2.) scanning: progressive
    b. Minimum illumination
        1.) Color mode: 0.15Lux (F1.6, 1/30sec)
        2.) Black & white mode: 0Lux (IR LED on)
    c. Lens: 3.2 ~ 10 mm (3.1x) motorized V/F

d. Max. Aperture Ratio F1.6(Wide)~F2.9(Tele)

e. Angle of view: [Wide] H: 100.3˚, V: 72.3°, D: 133.1°
[Tele] H: 31.2˚, V: 23.5°, D: 38.8°

f. Focus Control simple focus

g. Lens Type DC auto iris

2. Pan/Tilt/Rotate Range 0˚~350˚ / 0˚~67˚ / 0˚~355˚
3. IR Viewable Length: 30 m (98.4ft)
4. Electrical
   a. Power
      1.) Input Voltage / Current PoE (IEEE802.3af, Class3)
      2.) Power Consumption: Max 8.9W, typical 6.6W
5. Mechanical And Environmental
   a. Material:
      1.) Housing: Aluminum
   b. Dimensions (W x H): Ø137.0 x 106.1mm (Ø 5.39" x 4.18")
   c. Weight 430g (0.95 lb)
   d. Temperature:
      1.) Operating: -30° C to 50° C (-22° F to 122° F)
      2.) Storage: -30° C to 60° C (-22° F to 140° F)
   e. Humidity: 0 - 90%, non-condensing

PART 3 EXECUTION

3.01 INSTALLERS

A. Contractor personnel shall comply with all applicable state and local licensing requirements.

3.02 PREPARATION

A. The network design and configuration shall be verified for compatibility and performance with the camera(s).
B. Network configuration shall be tested and qualified by the Contractor prior to camera installation.
C. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
D. All firmware found in products shall be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA).
E. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.

3.03 INSTALLATION

A. The contractor shall carefully follow instructions in documentation provided by the manufacturer to insure all steps have been taken to provide a reliable, easy-to-operate system.
B. Before permanent installation of the system, the contractor shall test the system in conditions simulating the final installed environment.

3.04 STORAGE

A. The hardware shall be stored in an environment where temperature and humidity are in the range specified by the Manufacturer.

END OF SECTION

SECTION 283200 – VOICE EVACUATION FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fire alarm systems.

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Addressable system; multiplexed signal transmission dedicated to fire alarm service with speaker/strobes. This system shall be capable of handling the entire fire system requirements of the building including, but not limited to fire sprinkler monitoring, magnetic door hold open equipment, HVAC equipment, Elevator Recall and speaker/strobes throughout the entire building.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Premises protection includes Fully Sprinkled Type Occupancy.

C. Fire alarm signal initiation shall be by one or more of the following devices:
1. Manual stations.
2. Smoke detectors.
3. Heat Detectors
4. Verified automatic alarm operation of smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire extinguishing system operation.
7. Fire standpipe system.

D. Fire alarm signal shall initiate the following actions:
1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Activate voice/alarm communication system.
6. Record events in the system memory with ability to be printed.

E. Supervisory signal initiation shall be by one or more of the following devices or actions:
   1. Operation of a fire-protection system valve tamper.
   2. Operation of any duct detectors or induct detectors.

F. System trouble signal initiation shall be by one or more of the following devices or actions:
   1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
   2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
   3. Loss of primary power at the FACP.
   4. Ground or a single break in FACP internal circuits.
   5. Abnormal ac voltage at the FACP.
   6. A break in standby battery circuitry.
   7. Failure of battery charging.
   8. Abnormal position of any switch at the FACP or annunciator.
   9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
   10. Low-air-pressure switch operation on a dry-pipe.

G. System Trouble and Supervisory Signal Actions: Annunciate at the FACP and remote annunciators. Record the event in the system memory with ability to be printed.

1.6 SUBMITTALS

Prior to the start of work, the contractor shall provide a complete and comprehensive submittal for review by the engineer. Once the engineer of record has reviewed and approved the submittal, the contractor shall provide a complete submittal to the Authority Having Jurisdiction for their review and approval. The contractor is responsible for obtaining and paying for the fire alarm permits that may be required. The submittals shall be prepared by a NICET III certified, factory trained personnel. This person shall provide to the engineer of record the proof of NICET certification and proof of factory training if requested. Factory training means that this person has received training at the factory. These are to describe the proposed system and its equipment. Failure to provide a complete submittal shall be grounds for summary rejection of any incomplete submittal documentation. Contractors who provide re-submittal's, due to prior rejection shall be subject to a re-review fee, should the Engineer elect to do so. The complete submittal shall include, but not be limited to, all of the following material:

A. Power Calculations
   1. Battery capacity calculations shall be a minimum of 125% of the calculated requirement.
   2. Supervisory power requirements for all equipment.
   3. Alarm power requirements for all equipment.
   4. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25% spare capacity.
   5. Voltage-drop calculations for wiring runs demonstrating worst case condition.

B. Complete manufacturers catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

C. Complete drawings covering the following shall be submitted by the contractor for the proposed system. Floor plans in a CAD compatible format showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used. Floor plans will be prepared at 1/8" scale.

D. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on a flash drive and in a formatted printed form, as required for offsite editing, shall be submitted for evaluation by the owner.
   1. The program shall include all required interactive control functions between the local network systems and the methods for implementing these actions.

E. Provide the address, telephone number, and contact person(s) of the manufacturer's local service facility for normal and off-hour warranty issues.

F. If the fire alarm system and its equipment are supplied by a manufacturer's distributor, as part of the submittal documentation, the manufacturer shall provide, on its corporate letterhead, a "letter of support". Said "letter of support" shall state that, when in the opinion of the Engineer, the distributor's efforts require back-up and/or assistance, the manufacturer shall provide, at no cost to the Owner, all required technical support during the installation phase and for a one (1) year guarantee period starting on the date of final acceptance

by the owner and the authority having jurisdiction. If said "letter of support" is not submitted, the manufacturer's equipment will be deemed unacceptable and shall be grounds for summary rejection.

G. Provide a fire alarm system function matrix. Matrix shall illustrate alarm output events in association with initiating devices input events. Matrix shall represent a summary of the installed system alarm, supervisory and trouble functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at the time of bid. Failure to provide this requirement shall be cause for summary rejection of submittal documents where additional departures are discovered. (See NFPA-72 for minimum matrix requirements)

H. For each system control panel and/or transponder panel, provide panel ampere loading during both normal and alarm modes, with time calculations to substantiate compliance with battery back-up power requirements (battery Ampere-Hour capacity), described elsewhere in these specifications.

I. For each system control panel and/or transponder panel, provide written schedule of active and spare addresses provided on each addressable circuit to substantiate compliance with circuit usage/spare requirements, described elsewhere in these specifications.

J. For each system control panel and system transponder notification appliance circuit provide a written schedule of spare capability in amperes available for future possible use.

K. Provide manufacture's printed product data, catalog pages and descriptions of any special installation requirements and/or procedures. Drawings depicting any special physical installation requirements shall show physical plans, elevations, all dimensions, conduit entry, minimum access clearances and any other details required.

L. Provide shop drawings as follows:
1. Drawing or catalog page showing actual dimensions of the main FCS.
2. Drawing(s) or catalog page(s) showing actual dimensions of any additional system control panels, amplifier cabinets and/or battery cabinets.
3. Drawing or catalog page showing actual dimensions of the remote annunciator(s).
4. Single line riser diagram showing, all equipment, all connections and number and size of all conductors and conduits.
5. Provide samples of various items when so requested by the architect/engineer.

M. The fire protection contractor shall provide copies of certification for service technician's formal training by the system manufacture. As a minimum, certification documents shall indicate training dates, systems qualified, name of individual certified and current status.

N. Product Data: For each type of product indicated within 90 days of notice to proceed.

O. Within 30 days of notice to proceed, the contractor shall submit a programming printout and digital copy of the program to the Engineer for review.

P. Qualification Data: For Installer and fire alarm submittal designer: NICET Level III certification within 30 days of notice to proceed.

Q. Field quality-control test reports: provide test reports 10 days prior to final test requirements.

R. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

S. Documentation:
1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
    a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
    b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.

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

D. 30 days after award of bid, the contractor shall conduct a meeting with the owner; owner's representative, the Engineer and the architect to discuss compliance of the specifications and drawings.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Initiating Appliances: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
   2. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
   3. Keys and Tools: One extra set for access to locked and tamper proofed components.
   4. Audible and Visual Notification Appliances: One of each type installed.
   5. Fuses if applicable: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. FACP, Amplifiers and Equipment:
      a. Silent Knight by Honeywell.

   2. Wire and Cable:
      a. Comtran Corporation.
      b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
      c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
      d. West Penn Wire/CDT; a division of Cable Design Technologies.

   3. Audible and Visual Signals:
      a. System Sensor
      b. Wheelock
      c. Gentex

2.2 FACP

A. General Description:
   1. Modular, power-limited design with electronic modules, UL 864 listed.
   2. Addressable initiation devices that communicate device identity and status.
      a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
      b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

   3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:
1. Signaling Line Circuits: NFPA 72, Class B.
   a. System Layout: Each signaling line circuit shall be loaded no more than 80% capacity.
2. Notification-Appliance Circuits: NFPA 72, Class B.
3. Actuation of alarm notification appliances, annunciation, smoke control, shall occur within 10 seconds after the activation of an initiating device.
4. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

D. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Sound general alarm if the alarm is verified.
4. Cancel FACP indication and system reset if the alarm is not verified.

E. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

F. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

G. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.
1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

H. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.

J. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.
1. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory signal supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.
1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM CIRCUIT."

L. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.
2. Battery and Charger Capacity: Comply with NFPA 72.

M. Surge Protection:
1. Install surge protection on normal ac power for the FACP and its accessories. Comply with Division 26 Section "Transient Voltage Suppression" for auxiliary panel suppressors.
2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 FIRE ALARM DOCUMENT CABINET

A. General Description:
1. Minimum 18 gauge steel construction
2. Textured, baked on red enamel finish
3. Business card holder
4. Key ring hooks
5. Legend sheet for passwords and system information
6. Cover shall have white lettering that reads “SYSTEM RECORD DOCUMENTS”

2.4 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.
1. Single-action mechanism requiring single action to initiate an alarm, pull-lever type with integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.5 SYSTEM SMOKE DETECTORS

A. General Description:
1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Multipurpose type, containing the following:
   a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
   b. Heat sensor, combination rate-of-rise and fixed temperature.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
7. Where noted on drawings provide a welded wire screen protective cover.
8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
   a. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:
1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

    a. Sensor: LED or infrared light source with matching silicon-cell receiver.
    b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

    a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating status. Provide remote status and alarm indicator and test station where indicated.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay fan shutdown: Rated to interrupt fan motor-control circuit.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.
    1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

B. Speakers: shall be of sufficient number so that an alarm shall be clearly audible to all occupants of the building and/or fire area as required by these specifications. Mounting height shall be 96” to the centerline of the unit above the finished floor. Locations where ceilings prevent the installation at 96” centerline, the centerline of the unit shall be 6” below the ceiling.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
    1. Rated Light Output: as indicated.
    2. Strobe Leads: Factory connected to screw terminals.
    3. Where called for on plans to have a wire guard, provide and install a welded wire screen guard of appropriate size. Polycarbonate or other transparent protective covers are prohibited.

2.7 SPRINKLER SYSTEM REMOTE INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

    1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
    2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
    3. Rating: 24-V dc.

B. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Class 1.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LED's permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall where indicated to a circuit-breaker shunt trip for power shutdown and to release doors.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled according to UL 632.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of the device.
2. Finish: Paint of color to match the protected device.

2.13 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Line-Voltage Circuits: No. 12 AWG, minimum.

D. All wire and cable shall be installed in conduit.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed [30 feet (9 m)] .
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

E. Audible Alarm-Indicating Devices: Install between 80” and 96” above finished floor, this height is to the visual lens portion of the device, or on ceiling. Install speakers on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

F. Visible Alarm-Indicating Devices: Install integral to each alarm speaker if noted.

G. Device Location-Indicating Lights: Locate in public space near the device they monitor.

H. FACP: Mount as noted on drawings with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

I. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:
1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."
1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM CIRCUIT."

D. The location of the branch-circuit overcurrent protective device shall be permanently identified at the fire alarm control unit.

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 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. Testing Agency: Owner will engage a qualified testing and inspecting agency to witness field tests and inspections and prepare test reports. The contractor shall provide all personnel for this test. There shall be two tests, one prior to the Fire Marshall test and one with the Fire Marshall.

C. Perform the following field tests and inspections and prepare test reports:
   1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
   2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters.
   3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
   4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
      a. Detectors that are outside their marked sensitivity range shall be replaced.
   5. Test and Inspection Records: Prepare according to NFPA 72.

D. At no time shall the contractor make changes to the documents without written permission from the Engineer.

3.6 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 283200

SECTION 310120 - TRAFFIC CONTROL REQUIREMENTS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. In accordance with Manual on Uniform Traffic Control Devices for Highways, prepared by the National Joint Committee of Uniform Traffic Control Devices or as per local governing authority.

PART 2 - PRODUCTS - N/A

PART 3 - EXECUTION

3.1 TRAFFIC CONTROL

A. A construction and traffic control schedule indicating areas and type of work to be performed shall be submitted by the Contractor for review by the Architect prior to starting work on the Project. This schedule shall include proposed detours and any necessary traffic control devices and pavement markings.
   1. All traffic control plans shall be in conformance with the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways and the Transportation Department's Standard Details

B. A minimum of two working days notice shall be given before any changes in the schedule is made.

C. The Contractor shall provide an individual or individuals trained in traffic control to maintain and monitor required traffic control. Such individual or individuals shall have traffic control as a primary responsibility and duty and shall be available at all times that work is in progress to perform these duties. The Contractor is responsible for monitoring and maintaining traffic control devices during non-working days and non-working hours. During non-working days the individual shall visit the site at least once per day and perform maintenance of traffic control devices as necessary. The individual responsible need not be on duty but shall be on call during the construction phase and be available by telephone contact to correct problems and perform maintenance.

D. Detours. Detours, such as utilization of one or more traffic lanes for construction or maintenance shall be the responsibility of the Contractor. Costs for these items shall be included in the contract price. A detour plan showing the detour route and all applicable detour signing shall be furnished by the Contractor and approved by the governing authority before starting work on the project. Both lanes of traffic shall be open with appropriate construction signing during all non-working hours.

E. Local and Emergency Traffic. Pedestrian traffic shall be provided access to private properties at all times, except during urgent stages of construction when it is impracticable to carry on the construction and maintain traffic simultaneously.

F. No private driveway may be closed without the approval of the governing authority. No private driveways may be closed for more than eight (8) hours without written approval of the property owner.

G. Emergency traffic such as police, fire, school bus, mail delivery and disaster units shall be provided reasonable access at all times. The Contractor shall be liable for any damages which may result from his failure to provide such reasonable access.

H. The Contractor shall keep emergency vehicle dispatchers up-to-date on road detours and closures at all times.

I. Protection of Pedestrian and Vehicular Traffic. The Contractor shall take every precaution to protect pedestrian and vehicular traffic. Wherever, in the opinion of the Architect/governing authority, the Contractor has not provided sufficient or proper safety precautions and safeguards, he shall do so immediately and to the extent deemed advisable.

J. The posting of advance warning signs, barricades, traffic cones, flashers, etc., shall be in accordance with the current edition of Part VI of the "Manual on Uniform Traffic Control Devices for Streets and Highways" prepared by the National Joint Committee of Uniform Traffic Control Devices.

K. Flagmen. The Contractor shall furnish, at his own expense, all flag persons who may be needed.

L. Dust Control. It shall be the Contractor's responsibility to control dust on the project and on any detour by watering as directed by the Architect. Dust control on the project or on a detour shall be considered incidental to the project. Also see Division 1 requirements.

M. Traffic Control Within and Abutting the Project. The Contractor shall place and maintain all signs, barricades and warning lights within the limits of the project on the approach to the work area so that approaching traffic will be aware of construction. Signs which are required shall be furnished by the Contractor.

N. Barricades shall be furnished by the Contractor. The barricades shall be of a conventional design normally used in road construction work and painted "construction orange" with black stripes.

O. Traffic Control Signs. Standard traffic control signs required for construction will be furnished by the Contractor. He shall maintain them in a neat condition until the need for them has ceased, after which he shall carefully remove the signs.

END OF SECTION 310120

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically 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 and is 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 and is 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 more than 2 inches in diameter; and free of subsoil and 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 defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other 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.

1.5 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 videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. 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. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

D. Utility Locator Service: Notify utility locator service Call Before You Dig 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. 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.

I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

J. Dust Control: Water sprinkling shall be used to control release of dust during clearing and grubbing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

1. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. 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.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is included in Division 26 and Division 33 Sections.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees indicated to remain.

2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade and final finish grade whichever is greater.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and stockpile in areas approved by Architect.

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.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered (approximately 12 inches) in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within tree protection zones.
3. Dispose of surplus topsoil onsite as indicated or directed. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove fence posts/ footings, 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. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
    a. 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 or required improvements to be installed over removed improvements.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other 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 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. References
1. AASHTO M147-65 - Materials for Aggregate and Soil-Aggregate.
2. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop
3. ASTM C 136 –Method for Sieve Analysis of Fine and Course Aggregates.
4. ASTM D 698 ASTM D 698 - Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures using 5.5 lb Rammer and 12 inch Drop.
5. ASTM C 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D 3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
7. ASTM D 1557 – Test Methods for Moisture- Density Relations of Soil and Soil-Aggregate Mixtures using 10 lbs (4.54 kg) Rammer and 18” (457 mm) Drop.
8. **I.S.P.W.C. – Idaho Standards for Public Works Construction, current edition.**
9. **City of Jerome Supplemental Specifications, current edition.**

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade walks pavements turf and grasses and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation Photographic Documentation" for recording preexcavation and earth moving progress.
2. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
3. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
4. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

5. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 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 unit prices.
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 Landscape Architect. Unauthorized excavation, as well as remedial work directed by Landscape 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.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Controlled low-strength material, including design mixture.
   2. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:
   1. Warning Tape: 12 inches long; of each color.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to ASTM D 698 ASTM D 1557.

E. 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.

F. Contractor shall submit a detailed materials stockpile plan to the architect's representative and the owner for approval prior to any earthwork operations.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 1.

C. Aggregates: **Idaho Standards for Public Works Construction, current edition.**

D. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect 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.
   3. Contact utility-locator service for area where Project is located before excavating.

E. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

F. All gravel, subbase, and other imported fill materials other than topsoil shall only be stockpiled in proposed impervious areas. No gravel or rock materials shall be stock piled or temporarily

placed in proposed landscape or swale basin areas in order to prevent landscape contamination with rock materials.

1.6 PROJECT CONDITIONS

A. Verify survey benchmark and intended elevations for the work are as indicated.

B. 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.

C. 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.

D. Utility Locator Service: Notify utility locator service "Call Before You Dig" for area where Project is located before beginning earth moving operations.

E. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01.

F. Do not commence earth moving operations until plant-protection measures specified on drawings are in place.

G. 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.

H. Do not direct vehicle or equipment exhaust towards protection zones.

I. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, ML, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel or stone consisting of 6-inch minus select, clean, granular soil with no more than 50 percent oversize (greater than 3/4-inch) material and no more than 12 percent fines (passing No. 200 sieve), except that the maximum material diameter is no more than 2/3 the component thickness. These fill materials should be placed in layers not to exceed 12 inches in loose thickness and must be compacted a minimum of 95 percent of the maximum dry density as determined by ASTM D 698. Material must be moisture conditioned to achieve optimum moisture content prior to compaction.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve. Material must comply with **ITD Standard Specifications for Highway construction sections 303 and 703** for aggregates.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

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 0 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 0 to 5 percent passing a No. 4 sieve.

I. Sand: ASTM C 33; fine aggregate.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by 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.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 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.

3.4 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, Foundations, and Slab on Grade: Excavated under footings and slab on grade and within 12 inches of bottom of footings, place 12-inches of structural fill base course in 8-inch lifts, provide compaction testing. 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 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. Cut and protect roots according to requirements in Division 01 and as shown on drawings.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 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: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, 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 Division 01 Section "Temporary Tree and Plant Protection."

3.7 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.

3.8 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.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 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 and 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 12 inches of bottom of footings with structural fill soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. 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.

1. 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.

F. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

I. 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 and 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 95 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 95 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 required elevations within the following 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 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 and 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 or per plans, 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 and ASTM D 1557.

3.17 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 and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

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 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 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.

3.18 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.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus unsatisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Landscape Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

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SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
3. Division 31 Section "Dewatering" for dewatering system for excavations.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Monitor vibrations, settlements, and movements.

1.4 SUBMITTALS

A. Shop Drawings: For excavation support and protection system.

B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements."Qualification Data: For qualified land surveyor and professional engineer.

D. Other Informational Submittals:

1. Photographs or Videotape: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.
2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

a. Note locations and capping depth of wells and well points.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

a. Geotechnical report.
b. Existing utilities and subsurface conditions.
c. Proposed excavations.
d. Proposed equipment.
e. Monitoring of excavation support and protection system.
f. Working area location and stability.
g. Coordination with waterproofing.
h. Abandonment or removal of excavation support and protection system.

1.6 PROJECT CONDITIONS

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

1. Notify Architect no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Architect's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
2. The geotechnical report is referenced elsewhere in the Project Manual.

C. Survey Work: Engage a professional land surveyor to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application 3 inches.

E. Tiebacks: Steel bars, ASTM A 722/A 722M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

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SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Curbs and gutters.
   2. Walks.
   3. Mow strips.

B. Related Sections:

   1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.

C. References:
   1. ACI 301 - Specifications for Structural Concrete for Buildings.
   2. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
   3. ASTM A 615 - Specification for Deformed and Plain Billet-Steel for Concrete Reinforcement.
   4. ASTM C 33 - Specification for Concrete Aggregates.
   5. ASTM C 94 - Specification for Ready Mix Concrete.
   6. ASTM C 150 - Specification for Portland Cement
   7. ASTM C 260 - Specification for Air-Entraining Admixtures for Concrete.
   8. ASTM C 309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   9. ASTM C 494 - Specification for Chemical Admixtures for Concrete.
   10. ASTM C 143 - Test Method for Slump of Portland Cement Concrete
   11. **International Building Code – 2018 edition**.
   12. I.S.P.W.C. - Section 700 – Concrete. Idaho Standard Public Works Construction, current edition.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide data on joint filler, admixtures and curing compounds.

C. Submit shop drawings of reinforcing steel under provisions of Division 1.

D. Indicate reinforcement sizes, spacing, locations and quantities of reinforcing steel, bending and cutting schedules, splicing, and supporting and spacing devices.

E. Submit concrete slab control and expansion joint layout.

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

G. 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.

H. Qualification Data: For qualified Installer of detectable warnings ready-mix concrete manufacturer and testing agency.

I. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

J. Material Test Reports: For Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

K. Field quality-control reports.

L. Minutes of pre-installation conference.

1.5 QUALITY ASSURANCE

A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Perform work in accordance with ACI 301 requirements and State of Idaho Public Works Standards, Section 700.

C. Obtain cementitious materials from same source throughout.

D. Conform to **the City of Jerome** supplemental specifications for paving work within right-of-way.

E. 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").

F. 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.

G. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

H. ACI Publications: Comply with ACI 301 unless otherwise indicated.

I. Preinstallation Conference: Contractor shall Conduct conference at Project site prior to any form placement. Contact the landscape architect to schedule the conference.

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.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 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.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawnsteel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

D. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

F. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. 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.

H. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

I. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

J. Deformed-Steel Wire: ASTM A 496/A 496M.

K. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports

according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete 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.

P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type I. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class C.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. 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.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.
b. BASF Construction Chemicals, LLC; Confilm.
c. ChemMasters; Spray-Film.
d. Conspec by Dayton Superior; Aquafilm.
e. Dayton Superior Corporation; Sure Film (J-74).
f. Edoco by Dayton Superior; BurkeFilm.
g. Euclid Chemical Company (The), an RPM company; Eucobar.
h. Kaufman Products, Inc.; VaporAid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation, Inc.; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.

E. 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; Safe-Cure Clear.
c. Conspec by Dayton Superior; DSSCC Clear Resin Cure.
d. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
e. Edoco by Dayton Superior; DSSCC Clear Resin Cure.
f. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; AQUA KURE - CLEAR.
i. L&M Construction Chemicals, Inc.; L&M CURE R.

j. Meadows, W. R., Inc.; 1100-CLEAR SERIES.
k. Nox-Crete Products Group; Resin Cure E.
l. SpecChem, LLC; PaveCure Rez.
m. Symons by Dayton Superior; Resi-Chem Clear.
n. Tamms Industries, Inc., Euclid Chemical Company (The); TAMMSCURE WB 30C.
o. TK Products, Division of Sierra Corporation; TK-2519 WB.
p. Vexcon Chemicals Inc.; Certi-Vex Enviocure 100.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

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

a. ChemMasters; Exposee.
b. Conspec by Dayton Superior; Delay S.
c. Dayton Superior Corporation; Sure Etch (J-73).
d. Edoco by Dayton Superior; True Etch Surface Retarder.
e. Euclid Chemical Company (The), an RPM company; Surface Retarder Formula S.
f. Kaufman Products, Inc.; Expose.
g. Meadows, W. R., Inc.; TOP-STOP.
h. Metalcrete Industries; Surftard.
i. Nox-Crete Products Group; CRETE-NOX TA.
j. Scofield, L. M. Company; LITHOTEX Top Surface Retarder.
k. Sika Corporation, Inc.; Rugasol-S.
l. SpecChem, LLC; Spec Etch.
m. TK Products, Division of Sierra Corporation; TK-6000 Concrete Surface Retarder.
n. Unitex; TOP-ETCH Surface Retarder.
o. Vexcon Chemicals Inc.; Certi-Vex Envioset.

2.6 DETECTABLE WARNING MATERIALS

A. Detectable Warning Products:

1. Cast-in-Tact by Masco, or approved equal.

2.7 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 5 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.

1. Dowels: Galvanized steel, 3/4 inch in diameter, 24-inch minimum length.

2.8 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 meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4500 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
2. Air Content: 6 percent plus or minus 1.5 percent for 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 and retarding admixture when approved by Architect and required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals. as follows:

1. Fly Ash or Pozzolan: 15 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.9 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.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

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. 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 exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

E. Install bar where indicated on plans and details.

3.5 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. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. 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, walks, building columns, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 40 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
5. 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:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

    a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

    a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. 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 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 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.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

J. Screed paving surface with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters: When automatic machine placement is used for curb placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

M. Slip-Form Paving: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce paving to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

O. Cold-Weather 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.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated 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.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. 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.
2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 DETECTABLE WARNINGS

A. Blockouts: Form blockouts in concrete for installation of detectable paving units as shown on plans.

1. Tolerance for Opening Size: Plus 1/4 inch, no minus.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing

operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing moisture-retaining-cover curing curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- 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.
6. Vertical Alignment of Dowels: 1/4 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.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 WHEEL STOPS

A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.

B. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 5000 sq. ft.] 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, 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. Remove and replace concrete paving where test results indicate that 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.

3.13 REPAIRS 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 321313

SECTION 321723 - PAVEMENT MARKINGS

PART 1 – GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to the General Conditions, supplementary Conditions, and Division I General Requirements.

1.2 SECTION INCLUDES

A. Paint on pavement for traffic and parking.

1.3 RELATED SECTIONS

A. Section 321216: Asphalt Concrete paving.

1.4 REFERENCES

A. Standards listed below, with their designation in parenthesis, apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.

B. Federal Specifications (Fed. Spec.) :
   1. TT-P-110……Paint, Traffic, Black (Non-Reflectorized)
   2. TT-P-115……Paint, Traffic, Highway, White, and Yelllow.

C. Federal Standards 595a.

D. Idaho Standards for Public Works Construction (ISPWC) latest edition.

E. **City of Jerome** Supplemental Specifications and Details.

1.5 SUBMITTALS

A. Submit the following under the provisions of Section 013300.

B. Product data.
   1. Manufacturer's Certification and data for paint.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Paint for Marking Pavement: Fed. Spec. TT-P-115, color as shown.

2.2 EQUIPMENT

A. Paint Applicator: Apply all marking with mechanical equipment able to produce stripes of uniform quality conforming to the specified standards. The striping machine shall comply with CSS 84-3.04. Equipment must be capable of applying the marking widths as indicated. Provide pneumatic spray guns for hand application of paint in areas where a striping machine cannot be used.

PART 3 – EXECUTION

3.1 SURFACE PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Place all painting equipment and operations under the control of an experienced technician thoroughly familiar with the equipment, materials and marking layouts.

C. Thoroughly clean all surfaces to be marked before application of paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement with scrapers, wire brushing, sandblasting, approved chemicals, or mechanical abrasion as directed by the Owner's Representative.

D. Apply pavement markings soon after the surface has been cleaned and dried, but not until the surface has been inspected and permission to proceed is given by the Owner's Representative and the City of Nampa Engineering Department.

E. Establish control points for markings and provide templates to control paint application by type and color, at necessary intervals. Preserve and apply marking in conformance with the control points so established.

3.2 APPLICATION

A. Apply uniformly painted pavement marking of required color(s), length and width with true, sharp edges and ends on properly cured and prepared dried surfaces.

B. Traffic stripes shall conform to the dimensions and details shown on the plans. Alignment of lines shall have a tolerance of plus or minus one inch. The length and width of lines shall have a tolerance of plus or minus two inches and plus or minus one-eighth inch (one-fourth inch on curves), respectively. In the case of broken-line markings, the tolerance for the length of intervals shall not exceed the line length tolerance.

C. Atmospheric temperatures during painting operations shall be above 50 degrees F and rising and less than 95 degrees F.

D. Apply the paint at a wet film thickness of 0.015 inch (15 mils).

E. Apply paint in one coat. At the direction of the Owner's Representative and the **City of Jerome Engineering Department**, markings showing light spots may receive additional coats.

F. Follow the maximum drying time requirements of the paint manufacturer to prevent undue softening of the asphalt and pick-up, displacement, or discoloration of the markings by traffic. If there is a deficiency in drying of the marking, discontinue paint operations until the cause of the slow drying is determined and corrected. Remove and replace marking applied at less than the minimum application rates that deviate from true alignment or exceed stipulated length and width tolerances. Light spots, smears, or other deficiencies or irregularities will not be allowed.

3.3 PROTECTION

A. Conduct operations so that vehicular traffic can move effectively. Provide for safe pedestrian access where required.

B. Protect the newly painted markings so that paint will not be picked up by the tires of passing vehicles. Place warning signs at the beginning of wet lines, and at points well in advance of the marking equipment to alert approaching traffic from both directions.

C. Remove and replace damaged portions of markings at no additional cost to the Owner.

3.4 DETAIL PAVEMENT MARKING

A. Detail Pavement Marking is marking, exclusive of actual traffic lane marking, at parking stalls and at such other locations as shown on the Drawings.

B. Place detail pavement markings of the colors, widths and lengths, at the locations and of the design pattern shown on the Drawings. For additional details, refer to the latest edition of the **I.S.P.W.C. and City of Jerome** Supplemental Specifications and Details.

3.5 FINAL CLEAN-UP

A. Remove all debris, rubbish and excess material from project site.

END OF SECTION 321723

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SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.
2. Section 321400 "Unit Paving" for unit paving installations incorporating detectable warning unit pavers specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of exposed finish requiring color selection.

C. Samples for Verification: For each type of tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.5 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.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site**.

1.7 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 Adhesive Application:

1. Apply adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.

a. When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set unit pavers within 1 minute of spreading setting-bed mortar.

1.8 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

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in **the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1** for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing **joint material**, **setting material, anchor, and fastener** from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles **with replaceable surface** configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
1. Material: **Cast-fiber-reinforced polymer concrete tile** or **Molded glass- and carbon-fiber-reinforced polyester**.
2. Color: **As selected by Architect from manufacturer's full line**.
3. Shapes and Sizes:
    a. Rectangular panel, **24 by 24 inches or 24 by 48 inches.**
    b. Radius panel, nominal 24 inches (610 mm) deep by length per plan.
4. Dome Spacing and Configuration: **Manufacturer's standard compliant spacing** pattern.
5. Mounting:
    a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.

B. Cast-in-Place Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
1. Material:
    a. Stainless-Steel Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, [**Type 304**] [**Type 316L**].
        1) Finish and Color:
            a) Manufacturer's standard powder coat, **color as selected by Architect from manufacturer's full line**.
            b) Mill finish.
    b. Cast Iron: Gray iron, ASTM A 48/A 48M, CL 35.
2. Shapes and Sizes:
    a. Rectangular panel, **24 by 24 inches or 24 by 48 inches.**
    b. Radius panel, nominal 24 inches (610 mm) deep by **outside radius indicated on Drawings**.

3. Dome Spacing and Configuration: **Manufacturer's standard compliant spacing** pattern.
4. Mounting:

    a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with

detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.

2. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch (3 mm) from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

3.4 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 321726

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SECTION 321800 - PLAYGROUND EQUIPMENT AND STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. ASTM F1487-01: Consumer Safety Performance Specification for Playground Equipment for Public Use.
B. ASTM D 3363: Standard Test Method for Surface Area of Catalysts and Catalyst Carriers
C. ASTM D 2794: Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation
D. ASTM D 522: Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
E. ASTM D 2197: Standard Test Method for Adhesion of Organic Coatings by Scrape Adhesion
F. ASTM D 1308: Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
G. ASTM D 2247: Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
H. ASTM D 1248, type 2, class A: Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
I. ASTM B 221: Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 SUBMITTALS

A. Submit shop drawings, product data and Manufacturer's installation instructions for all materials and products proposed to be furnished and installed under this portion of the work.

B. Bidders shall supply a list of all individual play components included in the proposed structure with each IPEMA certified component identified on the list.

1.4 SUMMARY

A. This Section includes all playground equipment Associated with this project, including but not limited to:

1. Freestanding Structures
2. Composite Structures

B. Related Sections include the following:

1. Division 2 Section "Excavation" for filling and grading work.
2. Division 2 Section "Playground Surface Systems" for protective surfacing under and around playground equipment.
3. Division 2 Section "Poured-in-Place Concrete" for concrete footings.
4. Division 2 Section "Site Clearing" for removing old equipment.

1.5 DEFINITIONS

A. Composite Play Structures: According to ASTM F 1487, this means "two or more play structures, attached or functionally linked," creating one integral unit with more than one play activity.

B. Critical Height: Standard measure of shock attenuation. According to CPSC No. 325, this means "the fall height below which a life-threatening head injury would not be expected to occur."

C. Fall Height: According to ASTM F 1487, this means "the vertical distance between a designated play surface and the protective surfacing beneath it." The fall height of playground equipment should not exceed the Critical Height of the protective surfacing beneath it.

D. HDPE: High-density polyethylene.

E. IPEMA: International Play Equipment Manufacturers Association.

F. LLDPE: Linear low-density polyethylene.

G. MDPE: Medium-density polyethylene.

H. Play Structure: According to ASTM F 1487, this is "a free-standing structure with one or more components and their supporting members."

I. Protective Surfacing: According to ASTM F 1487, this means impact-attenuating "materials to be used within the use zone of any playground equipment" for playground surface systems.

J. PVC: Polyvinyl chloride.

K. Transfer Point: According to ASTM F 1487, this is "a platform or deck along an accessible route of travel or an accessible platform provided to allow a child in a wheelchair to transfer from the chair onto the equipment."

L. Use Zone: According to ASTM F 1487, this is "the area beneath and immediately adjacent to a play structure that is designated for unrestricted circulation around the equipment and on whose surface it is predicted that a user would land when falling from or exiting the equipment."

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has specialized in installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer of playground equipment and have a minimum of one CPSI on staff. Installer must be licensed in the State of this project and shall be NPSI certified. Copy of Certification to be included with initial submittal.

B. Manufacturer Qualifications: A firm whose playground equipment components have been certified by IPEMA's "3rd Party Certification" service.

1. Provide only playground equipment and play structure components bearing the IPEMA Certification Seal.

2. Provide at least three (3) references of recent jobs completed.

3. Provide playground equipment specified on drawings, or approved equal.

4. Substitutions must be made in accordance with specification Section 01600 and per the drawings.

5. All equipment shall meet all standards as specified in ASTM F 1487.

C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

D. Standards and Guidelines: Provide playground equipment complying with or exceeding requirements in the following:

1. American Society for Testing and Materials Consumer Safety Performance Specifications for Playground Equipment for Public Use (ASTM F 1487).
2. U.S. Consumer Products Safety Commission Guidelines (CPSC) No. 325, "Handbook for Public Playground Safety", current edition.
3. Guide to ADA Accessibility Guidelines for Play Areas, published March 2001 by the U.S. Architectural and Transportation Barriers Compliance Board.
4. Label play structures with warning label and manufacturer's identification per ASTM F 1487.
5. Compliance to ASTM standards and CPSC guidelines shall be independently certified by the International Play Equipment Manufacturer's Association (IPEMA).

E. Furnish paint for touch-up as required.

F. Install pre-manufactured items, poured-in-place or pre-cast items, and all related materials required to complete the work indicated on the drawings and/or specified.

G. Materials Inspection: The Contractor shall inspect all items upon delivery to ensure no damage to material or finish. Minor repairs and/or touch up shall be accepted only upon prior authorization from the Landscape Architect and shall conform, at minimum, to manufacturer's standard.

H. Installer shall provide a follow-up inspection of the equipment within one year of the installation date. An inspection results report shall be supplied to the school district.

I. Installation Company shall warranty play equipment build to be installed as per manufacturer's specifications and for a period of one year.

1.7 EXTENDED WARRANTY

A. Manufacturer shall offer the following warranties on the materials and components of its system:
1. Lifetime limited warranty on support posts (uprights).
2. 15 Year limited warranty on expanded metal and punched steel decks, pipes, rails, loops and rungs.
3. 15 Year limited warranty on roto-molded and polyethylene components.
4. Lifetime limited warranty on powerlock and hardware.

1.8 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect at least two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Before excavating, contact utility-locator service for area where Project is located.

1.9 COORDINATION

A. Coordinate construction of equipment use zones and fall heights during installation of playground equipment with installation of protective surfacing specified in Division 32. Sequence work so protective surfacing can be installed immediately after concrete footings have set.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified on the drawings, or approved equal.

B. Products: Subject to compliance with requirements, provide the product specified on the drawings.

C. Manufacturers: Manufacturer shall be ISO 9001/2000 certified. Manufacturer shall show IPEMA certification of compliance for each component that the product conforms with the requirements of ASTM F1487-01.
1. Playcraft Systems, 123 North Valley Drive, Grants Pass, Oregon 97526, 800-333-8519.
2. Approved Equal as outlined in Division 1.

2.2 PLAYGROUND EQUIPMENT, GENERAL

A. Playground shall be provided and installed by the contractor. Contractor is responsible to coordinate delivery times with the owner.

2.3 ACCESSORIES

A. Provide all anchorage devices and materials required for a complete installation.

2.4 CAST-IN-PLACE CONCRETE

A. Concrete Materials and Properties: Comply with requirements in Division 2 Section "Cast-in-Place Concrete to produce normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch- maximum size aggregate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, site surface and subgrade drainage, and other conditions affecting performance.

1. Do not begin installation before final grading required for placing protective surfacing is completed, unless otherwise permitted by Architect.

2. Elevation of equipment shall be based on finish grade of protective surfacing, and per manufacturer's recommendations.

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

3.2 PREPARATION

A. Verify locations of playground perimeter and pathways. Verify that playground layout and equipment locations comply with requirements for each type and component of equipment.

3.3 INSTALLATION, GENERAL

A. General: Comply with manufacturer's written installation instructions, unless more stringent requirements are indicated. Anchor playground equipment securely, positioned at locations and elevations indicated on Shop Drawings.

1. Minimum Equipment Height: Coordinate installed heights of equipment and components with installation of protective surfacing. Set equipment so fall heights and elevation requirements for age group use and accessibility are within required limits to ensure minimum equipment height. Verify that playground equipment elevations comply with requirements for each type and component of equipment.

B. Install as shown on the drawings and in strict conformance with manufacturer's recommendations. Notify Construction Manager in the event of any discrepancies.

C. Touch-up paint, as necessary, all blemishes incurred during shipping or assembly, color as designated, to manufacturer's standards.

D. Post and Footing Excavation: Hand-excavate holes for posts and footings to dimensions, profile, spacings, and in locations indicated on Drawings, in firm, undisturbed or compacted subgrade soil. Level bearing surfaces with drainage fill to required elevation.

E. Post Setting: Set main-frame equipment posts in concrete footing. Protect portion of posts above footing from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Verify that posts are set plumb or at the correct angle and are aligned and at the correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

1. Concrete Footings: Smooth top, and shape to shed water.

2. Depth of footing shall be per manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

A. Arrange for playground equipment manufacturer's technical personnel to inspect playground and playground equipment and components during installation and at final completion and to certify compliance with the following:

1. ASTM F 1487.
2. CPSC No. 325.

B. Notify Owner's Representative 48 hours in advance of date and time of final inspection.

C. Technical personnel, inspecting the equipment shall be different from personnel installing the equipment.

3.5 ADJUSTING

A. Adjust movable playground equipment components to operate smoothly, easily, and quietly, free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.

B. Upon completion of the installation of playground equipment, check each item and verify that all equipment is properly installed; verify that all trim is in place; adjust all components as necessary to ensure proper operation; remove all labels from equipment.

C. Make necessary adjustments for safe, efficient and smooth operation.

3.6 CLEANING

A. After completing playground equipment installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

3.7 PROTECTION

A. Protect through Substantial Completion.

3.8 DELIVERY

A. Delivery of necessary equipment shall be to each site.

END OF SECTION 321800

SECTION 321822 SYNTHETIC PLAYGROUND TURF

PART 1 – GENERAL

1.01 WORK

A. Furnishing, delivery, installation and warranty of a complete synthetic turf system including drainage, synthetic turf, and resilient infill material.

1.02 RELATED SECTIONS

A. Section 02300 – Earthwork
B. Section 321123 – Aggregate subbase

1.03 REFERENCES

A. ATSM Standard Test Methods
    - D1577 – Standard Test Method for Linear Density of Textile Fiber
    - D5848 – Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Covering
    - D418 – Standard Test Method for Testing Pile Yarn Floor Covering Construction
    - D1338 – Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings
    - D1682 – Standard Method of Test for Breaking Load and Elongation of Textile Fabrics
    - D5034 – Standard Test Method of Breaking Strength and Elongation of Textile Fabrics (Grab Test)
    - F1551 – Standard Test Methods for Water Permeability
    - D2859 – Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
    - F355 – Standard Test Method for Shock-Absorbing Properties of Playing Surfaces
    - D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
B. STC Suggested Guidelines for the Essential Elements of Synthetic Turf Systems

1.04 PROJECT CONDITIONS

A. Coordinate all work with the work of other sections to avoid delay and interference with other work.
B. Protect excavations by shoring, bracing sheeting, underpinning, or other methods as required to prevent cave-ins or loose dirt from entering excavations. Barricade open excavations and post warning lights at work adjacent to public streets and walks.

1.05 SITE INSPECTION

A. The inspection shall include a check for planarity. The finished surface shall not vary from a true plane more than 1/4” in 10 feet when measured in any direction. The Contractor shall provide all required tools and materials needed for the planarity check, which may include but not be limited

to, a laser level, string line, straight edge and/or other assessment materials. The Contractor shall mark in the field any deviations from grade in excess of those specified above, as well as provide a marked up plan locating the deviations. The Contractor shall correct any deviations to the satisfaction of the Engineer and Synthetic Turf installer.

B. The compaction of aggregate base shall be 95% to Standard Proctor and surface tolerances shall not exceed ¼" over 10 feet.
C. The Contractor shall have a state registered surveyor conduct an elevation survey of the area in a 25' grid to determine and verify that subgrade elevations and slopes are within previously specified tolerances. This elevation survey may require further verification of smaller areas within the 25' grid if determined necessary by the Engineer.
D. When any or all corrective procedures have been completed, the finished sub-base surface must be re-inspected, with the same representatives attending as the initial inspection. If required, additional repair and inspections are to be conducted until the subbase surface is deemed acceptable by the Engineer and Synthetic Turf Installer
E. Once the sub-base surface has been deemed acceptable, the Contractor shall submit a written certificate indicating the acceptance of:
    1. The sub-base construction finished surface as totally suitable for the application of the selected synthetic turf system, and
    2. The sub-base construction as totally suitable for work under this section to proceed with the final installation and fully warrant the athletic surface installation for the period and conditions specified herein.
F. Commencement of work under this section shall constitute acceptance of the work completed under other sections by the Contractor, acceptance of dimensions of the subbase, and hence, no claims for extra work based upon these conditions will be permitted.

1.06 ENVIRONMENTAL CONDITIONS

A. Install synthetic turf surfacing only when ambient air temperature is 35 F or above and the relative humidity is below 35% or as specified by the product manufacturer. Installation will not proceed if rain is imminent.
B. Install product only when prepared base is suitably free of dirt, dust, and petroleum products, is moisture free and sufficiently secured to prevent unwanted pedestrian and vehicular access.
C. Maintain all benchmarks, monuments, and other reference points. If disturbed or destroyed, replace as directed.
D. Adjacent streets, sidewalks, and property shall be kept free of mud, dirt, or similar nuisances resulting from earthwork operations.

1.07 QUALITY CONTROL

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section. The Turf Manufacturer:
    1. Basis of design shall be "SoftLawn EZ Play PL929" synthetic turf system as provided by STI®. www.synthetic-turf.com
    2. Materials other than those listed must be approved 15 days prior by written addendum. Materials from non-approved manufacturers will not be accepted.
    3. Must be experienced in the manufacturing of tall pile synthetic infill grass systems with the same fiber as specified.
    4. Manufacturer must be a member in good standing with the STC.
    5. Manufacturer must utilize best practices as certified by ISO-9001 and ISO-14001.
    6. Manufacturer must be owned and operated in the U.S.A.

7. Manufacturer must have no periods of insolvency over the last 25 years.

B. Installer Qualifications: Company specializing in performing the work of this section.
   1. The Synthetic Turf Installer must provide competent workmen skilled in this type of synthetic grass installation. All technicians must have installed similar synthetic turf.

C. Prior to the beginning of installation, the Synthetic Turf Installer shall inspect the subbase. The installer will accept the sub-base in writing when the general contractor provides test results for compaction, planarity and permeability that are in compliance with the synthetic turf manufacturer's recommendations and as stated herein.

D. Remove defective Work, whether the result of poor workmanship, defective products or damage, which has been rejected by the Engineer as unacceptable. Replace defective work in conformance with the Contract Documents.

1.08 SUBMITTALS

A. Submit the following with Proposal:
   1. Submit the exact product name/description as well as the name and location of the manufacturers and suppliers of each component. Manufacturers and suppliers must not be changed after the contract is awarded unless approved by the Owner in writing.
   2. Submit two (2) samples, 12"x12" minimum size, illustrating details of finished product as bid, including full cross section of subbase, turf, and infill material.
   3. Product Literature: Submit two (2) copies of manufacturer's recommended installation and maintenance information, including any technical criteria for evaluation of the installed product. Descriptions of all equipment recommended for the maintenance and repair of turf product, as well as a list of any activities not recommended relative to the warranty.
   4. Submit a 1-lb sample of the selected bid infill material(s).
   5. A letter and specification sheet certifying that the products of this section meet or exceed specified requirements.
   6. Certified copies of independent (third-party) laboratory reports on ASTM tests as follows:
      a. Pile Height, Face Width & Total Fabric Weight, ASTM D418 or D5848
      b. Primary & Secondary Backing Weights, ASTM D418 or D5848
      c. Tuft Bind, ASTM D1335
      d. Grab Tear Strength, ASTM D1682 or D5034
   7. ASTM test submittals may vary by no more than ¼" and 6 oz. of the specified product to bid. Bid winner must show NEW ASTM TESTS with contract submittals.
   8. Name and experience of the designated supervisory personnel assigned to this project shall be submitted with the proposal. Changes to this assignment after contract can only be made if approved in writing by the Owner. Include a listing of other on-site personnel and their experience.
   9. The Synthetic Turf Installer and Turf Manufacturer shall provide evidence that the turf system does not violate any other manufacturer's patents, patents allowed or patents pending.

1.09 WARRANTY

A. The Contractor shall provide a minimum eight (8) year warranty policy by the manufacturer, against defects in materials and workmanship. Defects shall include, but not be limited to ultraviolet ray fading, degradation, or excessive wear of fiber.

B. Warranty shall be for full replacement of any damaged product within the warranty period. Warranty shall be comprehensive and sufficient to replace all turf if necessary.

C. Warranty shall become effective from the date of substantial completion.

D. The Warranty shall contain no usage limits for warranted turf.

E. Submit Manufacturer Warranty and ensure that forms have been completed in Owner's name and registered with Manufacturer.

PART 2 PRODUCTS

2.01 SUPPLIER QUALIFICATIONS

A. The Owner has conducted an extensive review of synthetic turf products, including visiting installed sites and review of other agencies' review criteria. Based upon their research, they have established the following criteria for acceptance of a synthetic turf product. No variation from these criteria shall be allowed. The Owner's review is considered final.
B. The Synthetic Turf Installer shall have minimum experience of at least 5 years, actively selling, installing and maintaining in-fill synthetic turf project of similar size.
C. The Synthetic Turf Installer must provide a list of references based on previous installations.
D. Installation team shall be established, insured installation firm experienced as a premium turf installer with suitable equipment and supervisory personnel, with a minimum of 5 years' experience with 15 foot wide tufted materials.

2.02 TURF SYSTEM

A. Turf Fiber:
   1. The turf fiber must be tufted to the backing with a minimum tuft bind of 10 pounds.
   2. The tufted fiber weight shall be a minimum of 60 ounces per square yard.
   3. The turf fiber shall be non-abrasive and a minimum of 100 microns thick.
   4. The turf fiber must contain less than 100 ppm of lead chromate in all colors.
   5. The turf fibers must be from the same dye lots.
   6. The turf fibers must be guaranteed for a period of Eight Years not to fade or fail (as distinguished from a change in texture) or have a pile height decrease to 50% of pile height as result of UV degradation.
   7. The turf fiber must retain a minimum of 75% of its original fibril width after 10,000 cycles on the Lisport Studded Roll Test Machine.

   8. The pile fiber shall possess the following characteristics:

Characteristic	Value	Test
Linear Density (Denier)	13600	ASTM D 1577
Yarn Thickness	00 Microns (PE Mono); 100 Microns (PP	ASTM D 3218
Tensile Strength	71 N (PE Mono);16.5 N (PP)	ASTM D 2256
Pile Weight*	60 oz./yd2	ASTM D 5848
Fiber manufacturer must be from the same source		

The above specifications are nominal. *Values are +/- 5%.

9. The pile fabric shall possess the following physical characteristics

Characteristic	Value	Test
Finished Pile Height*	1.25" (32mm)	ASTM D 5823
Product Weight (total)*	87 oz./yd2	ASTM D 3218
Primary Backing Weight*	7.4 oz./yd2	ASTM D 2256
Secondary coating Weight**	20 oz./yd2	ASTM D 5848
Fabric Width	15' (4.57m)	ASTM D 5793
Tuft Gauge	3/8"	ASTM D 5793
Grab Tear Strength	200-1b-F	ASTM D 5034
Tuft Bind	>10-1b-F	ASTM D 1335
Infill (Sand)	2 lbs Silica Sand	None
Infill (Rubber)	N/A	None
Except where noted as a minimum, the above specifications are nominal.		
* Values are +/- 5%. **All values are +/- 3 oz./yd2.		

B. Backing Material
   a. Primary Backing:
      i. Primary backing must be a dual layered woven polypropylene material, ArmorLoc™3L.
      ii. Primary backing system weight must be a minimum of 7.0 ounces/square yard.
   b. Secondary Backing:
      i. Secondary backing system weight must be a minimum of 20 ounces/ square yard.
      ii. Secondary backing SilverBack™ shall saturate the primary backing and effectively lock the fiber tufts in place to the primary backing.
      iii. Secondary backing must be a heat activated polyurethane coating with no vegetable based polyols.
      iv. Secondary backing system shall have minimum tuft bind strength of 10 pounds.
      v. Secondary backing must have Drainage Perforations: 3/16” to ¼” diameter at 4 inches or less on center each way. Non-perforated backing is not acceptable.

C. Turf roll seams: to be sewn or glued on site so that no openings larger than the porous backing mat openings are created. All turf fabric edges to be securely bound as per the perimeter detail design. Adhesives for joining seams of turf together shall be Nordot 34G Glue, Mapei 2K, Turf Claw, hot melt technology or equivalent. No substitutions.

D. Fabric surface: shall be constructed and installed in minimum widths of 15 feet with no longitudinal or transverse seams.

E. The entire system shall be resistant to weather, including ultra-violet light and heat degradation; insects, rot, mildew and fungus growth and be non-allergenic and non-toxic.

F. The turf material shall be non-combustible and pass the DIN standard Pill Burn test or ASTM D 2859.

2.03 SYNTHETIC GLUE MATERIAL

A. Adhesive products shall be Nordot 34G, Mapei 2K, Turf Claw, hot melt technology or equivalent as approved by the engineer.

B. Any adhesive products required for the installation of a proposed turf system shall be purpose-suited to the system. The material and application methods shall be as recommended by the adhesive manufacturer.
C. Disposal of adhesive containers and unused adhesives as well as any fees resulting from such disposal shall be the responsibility of the Contractor.

2.04 INFILL MATERIAL

A. The synthetic infill material shall consist of a blend of graded, silica sand and treated and mixed ground rubber.
   1. Sand: specially-graded, dust-free silica sand shall be placed on the turf in a minimum quantity of 1 pound/ square foot and shall include test results that demonstrate the following minimum properties:
      a. Color – tan
      b. Sand shall be round non-angular in shape
      c. Roundness – 0.6+
      d. Hardness - 0.6-0.8 on the Mohs Scale
      e. Size – 1.00 mm ± 0.15 mm
      f. Density – 90 – 95 lbs/ cu ft.
      g. Dust - < 0.001 %
      h. Angle of Repose - < 30°
      i. Sand shall be heavy metal safe
   2. Rubber: Rubber is SBR ambient (styrene butadiene rubber) rubber, color black, 10-18 mesh, that is 99% fiber free and is heavy metal safe. Rubber shall be placed on the turf in a minimum quantity as referenced the table in Section 2.02 in this document and shall be of the following Mesh Size Distribution:

Mesh Size	% Retained
a. 10	0-15%
b. 12	5-30%
a. 16	40-70%
b. 20	15-35%
c. 30	0-10%
d. 40	0-1%
e. Pan	0-1%

PART 3 EXECUTION

3.01 GENERAL

A. Installation of the synthetic turf system is to comply with the manufacturer's recommendations, requirements and the reviewed and approved shop drawings.
B. Perform all work in strict accordance with the Contract Documents and the manufacturer's specifications and instructions. Only those skilled technicians proposed in the bid phase are to be assigned to this project by the Contractor.
C. The designated Supervisor for the Synthetic Turf Installer must be present during any and all construction activity associated with the field installation, including testing, cleanup and training.
D. All products and equipment are to be from sources approved by the authorized turf manufacturer and conform to the specifications.

3.02 PRODUCT DELIVERY, STORAGE & HANDLING

A. Deliver products to site in original containers and wrappers as agreed between the Engineer and Contractor. Inspect products upon delivery for damage.
B. Store products in a location and in a position that protects them from crush damage or any other defects.
C. Handle and store (on and off site) all materials safely to ensure their physical properties are not adversely affected and that they are not subject to vandalism or damage.
D. Rubber and sand infill shall arrive dry and loose.
E. Adhesives shall arrive in dry, sealed containers.

3.03 TURF INSTALLATION

A. Install synthetic turf system in accordance with the manufacturer's written installation instructions.
B. Turf shall be attached to the perimeter edge as shown in the construction plans and as per the manufacturer.
C. All seams shall be brushed thoroughly before infill materials are installed.
D. All terminations shall be as detailed and approved in the shop drawings.

3.04 INFILL INSTALLATION

A. The synthetic turf shall be thoroughly brushed prior to installation of infill materials to remove wrinkles.
B. Turf shall remain free draining at all times before, during and after the infill materials are installed.

3.05 CLEANING AND COMPLETION

A. Protect all installed work from other construction activities as installation progresses.
B. The Contractor shall keep the area clean throughout the construction period and free from the installation process, including track surfaces.
C. Upon completion of the installation, thoroughly clean surfaces and site of all refuse resulting from the installation process, including track surfaces.
D. Any damage to existing fixtures or facilities resulting from the installation of the synthetic turf system shall be repaired to original condition at the Contractor's expense prior to Substantial Completion and commencement of the Warranty Period.
E. A deficiency list will be produced by the Engineer at the conclusion of the project. All installation project deficiencies not in dispute must be remedied by the Contractor prior to the issuance of a certificate of Substantial Completion.
F. Contractor to provide a written acceptance by the Turf Manufacturer that the turf and base system is installed in accordance with their recommendations prior to final completion.

END OF SECTION 321822

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SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.
3. Horizontal-slide gates.

B. Related Requirements:

1. **Section 033000 "Cast-in-Place Concrete"** for cast-in-place concrete **post footings**.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the **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.

1.4 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.
c. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.

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.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of chain-link fence and gate.

B. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by **a qualified testing agency**.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

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

B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.7 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.

1.8 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.
c. Faulty operation of gate operators and controls.

2. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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: 90 mph.

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**.
b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

B. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 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:
   a. 6’-0” Perimeter Fence.
2. Steel Wire for Fabric:
   a. Wire Diameter: **0.148 inch (9 gauge)**
   b. Mesh Size:
      1) Perimeter Fence: **2 inches (50 mm)**.
   c. Zinc-Coated Fabric: ASTM A 392, Type II, **Class 1, 1.2 oz./sq. ft. (366 g/sq. m)** with zinc coating applied **before** weaving.
   d. Powder-Coated Fabric: ASTM A 392, Type II, **Class 1, 1.2 oz./sq. ft. (366 g/sq. m)** with powder coating applied **before** weaving.

   e. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: **Knuckled at both selvages**.

2.3 FENCE FRAMEWORK

A. Posts and Rails: 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:
   a. **Perimeter Fence: 72 inches**.

2. Light-Industrial-Strength Material: **Group IC-L, round steel pipe, electric-resistance-welded pipe**.

    a. Line Post:
        1) Up to 5’-0” height: **1.9 inches** in diameter.
        2) 5’-0” to 12’-0” height: **2.375 inches** in diameter.
    b. End, Corner, and Pull Posts:
        1) Up to 5’-0” height: **2.375 inches (60 mm** in diameter.
        2) 5’-0” to 12’-0” height: **2.875 inches (73 mm)** in diameter.

3. Heavy-Industrial-Strength Material: **Group IA, round steel pipe, Schedule 40**.

    a. Line Post over 12’-0” height: **4.0 inches (102 mm) in diameter**.
    b. End, Corner, and Pull over 12’-0” height: **4.0 inches (102 mm) in diameter**.

4. Horizontal Framework Members for fence height over 6’-0”: **Intermediate, top, and bottom** rails according to ASTM F 1043.
5. Horizontal Framework Members for fence height of 6’-0” and below: T**op** rails and bottom tension wire according to ASTM F 1043.

    a. Top Rail: **1.66 inches (42 mm) in diameter**.

6. Brace Rails: ASTM F 1043.
7. Coating for Steel Framework:
    a. Powder coating, color per Architect from manufacturer’s standard colors.
8. Metallic Coating for Steel Framework:

    a. Type A: Not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating according to ASTM A 653/A 653M.
    b. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
    c. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
    d. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
    e. Coatings: Any coating above.

2.4 TENSION WIRE

A. Powder-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824.
    a. Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.

B. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:

1. Type II: Zinc coated (galvanized) by **hot-dip** process, with the following minimum coating weight:
    a. Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and **single** and **double** swing gate types.

1. Gate Leaf Width: **As indicated** on plans.
2. Framework Member Sizes and Strength: Based on gate fabric height **of 72 inches (1830 mm) or less**.

B. Pipe and Tubing:

1. Powder Coated Steel: ASTM F 1043 and ASTM F 1083; **finish to match fence framework**.
2. Gate Posts: **Round tubular steel**.
3. Gate Frames and Bracing: **Round tubular steel**.

C. Frame Corner Construction: **assembled with corner fittings**.

D. Hardware:

1. Hinges: **360-degree inward and outward** swing.
2. Latch: Permitting operation from both sides of gate **with provision for padlocking accessible from both sides of gate**.
3. Lock: **Manufacturer's standard** internal device.
4. Closer: **Manufacturer's standard**.

E. Pipe and Tubing:

1. Powder-Coated Steel: **Protective coating and finish to match fence framework**.

2. Zinc-Coated Steel: **Protective coating and finish to match fence framework**.
3. Gate Posts: ASTM F 1184. Provide **round tubular steel** posts.
4. Gate Frames and Bracing: **Round tubular steel**.

F. Frame Corner Construction: **assembled with corner fittings**.

G. Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from **powder coated steel** or **galvanized steel location per plan**.
2. Latch: Permitting operation from both sides of gate **with provision for padlocking accessible from both sides of gate**.
3. Lock: **Manufacturer's standard** internal device allow for future card reader control assembly.

2.6 HORIZONTAL SLIDE GATES

A. General: ASTM F 900 for gate posts and **single** and **double** horizontal slide gate types.

1. Gate Leaf Width: **As indicated** on plans.
2. Framework Member Sizes and Strength: Based on gate fabric height **of 72 inches (1830 mm) or less**.

B. Pipe and Tubing:

1. Powder Coated Steel: ASTM F 1043 and ASTM F 1083; **finish to match fence framework**.
2. Gate Posts: **Round tubular steel**.
3. Gate Frames and Bracing: **Round tubular steel**.

C. Frame Corner Construction: **assembled with corner fittings**.

D. Hardware:
1. Latch: Permitting operation from both sides of gate **with provision for padlocking accessible from both sides of gate**.
2. Lock: **Manufacturer's standard** internal device.
3. Closer: **Manufacturer's standard**.

E. Pipe and Tubing:

1. Powder-Coated Steel: **Protective coating and finish to match fence framework**.

2. Zinc-Coated Steel: **Protective coating and finish to match fence framework**.
3. Gate Posts: ASTM F 1184. Provide **round tubular steel** posts.
4. Gate Frames and Bracing: **Round tubular steel**.

F. Frame Corner Construction: **assembled with corner fittings**.

G. Hardware:

1. Hangers, Roller Assemblies, and Stops: Fabricated from **powder coated steel** or **galvanized steel finish location per plan**.
2. Latch: Permitting operation from both sides of gate **with provision for padlocking accessible from both sides of gate**.
3. Lock: **Manufacturer's standard** internal device allow for future card reader control assembly.

2.7 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 Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: **Pressed-steel or round-steel tubing** not less than 6 inches (152 mm) long.
2. Rail Clamps: Line and corner boulevard clamps for connecting **intermediate and bottom** rails to posts.

E. Tension and Brace Bands: **Pressed steel**.

F. Tension Bars: **Steel** length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: **Steel, powder coated or Steel, hot-dip galvanized (location per plan) after threading** rod and turnbuckle or other means of adjustment.

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. Powder coated Steel: **0.148-inch (11 gauge)** diameter wire**; powder coating thickness matching coating thickness of chain-link fence fabric**.

b. Hot-Dip Galvanized Steel: **0.148-inch (11 gauge)** diameter wire**; galvanized coating thickness matching coating thickness of chain-link fence fabric**.

I. Finish (location per plans):

1. Powder Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft.

2. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of zinc.

2.8 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.

2.9 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for **a certified survey of property lines, legal boundaries, and irrigation ditch easements,** site clearing, earthwork, pavement work, and other conditions affecting performance of the Work. Contractor shall be responsible to provide recorded documents of all property lines, legal boundaries, and easements to establish and verify fencing locations prior to any fencing installation. Contact Architect immediately if encroachment or discrepancies exist between any legal boundaries and fencing locations.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
2. Do not begin installation before boundary and easement work is completed.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 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 Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts **in concrete** at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.

b. Concealed Concrete: Place top of concrete **2 inches (50 mm)** below grade to allow covering with surface material.

D. 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 (152 m), space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at **10 feet (3 m)** o.c.

F. 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 (1830 mm) 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.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

H. 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.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to **outside** of enclosing framework. Leave **1-inch (25-mm)** 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.

K. 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 (380 mm) o.c.

L. 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 (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.

M. 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.**

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GATE-OPERATOR INSTALLATION

A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations according to gate-operator component manufacturer's written instructions and as indicated.

3.6 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence, and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of **1500 feet (450 m)**]. If less than 1500 feet distance provide a minimum of one grounding rod.
3. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of **750 feet (225 m)**.
4. Ground fence on each side of gates and other fence openings.

    a. Bond metal gates to gate posts.
    b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (457 mm) below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet (45 m) on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

F. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

H. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

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SECTION 323119 DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. REFERENCES
1. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2000.
2. ASTM 900 – Standards Specifications for Industrial and Commercial Swing Gates.
3. ASTM D523 – Standard Test Method for Specular Gloss.
4. ASTM D822 – Standard Practice for Filtered Open-Flame Carbon-Arc Exposures f Paint and Related Coatings.
5. ASTM D 1654 – Standard Test Method of Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

1.2 SUMMARY

A. Section Includes:

1. Decorative metallic-coated steel tubular picket fences.

B. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for concrete post concrete fill.
2. Division 26 Sections for electrical service and connections for motor operators, controls, limit and disconnect switches, and safety features and for system disconnect switches.
3. Division 31 Section "Earth Moving" for site excavation, fill, and backfill where decorative metal fences and gates are located.

1.3 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.4 SUBMITTALS

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

B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each fence material and for each color specified.

1. Provide Samples 12 inches in length for linear materials.

D. Welding certificates.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for decorative metallic-coated steel tubular picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products. Installer specializing in the installation of products and work specified in the section with not less than 5 years of documented experience.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.

PART 2 - PRODUCTS

2.1 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.

C. Tubing: ASTM A 500, cold formed steel tubing.

D. Bar Grating: NAAMM MBG 531.

1. Bars: Hot-rolled steel strip, ASTM A 1011/A 1011M, Commercial Steel, Type B.
2. Wire Rods: ASTM A 510.

E. Castings: Either gray or malleable iron unless otherwise indicated.

1. Gray Iron: ASTM A 48/A 48M, Class 30.
2. Malleable Iron: ASTM A 47/A 47M.

2.2 COATING MATERIALS

A. Shop Primers for Steel: Provide primers that comply with Division 09 Section "Exterior Painting." Division 09 Section "High-Performance Coatings."

B. Epoxy Zinc-Rich Primer for Steel: Complying with MPI #20 and compatible with coating specified to be applied over it.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

2. Use primer with a VOC content of 340 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

2. Use product with a VOC content of 400 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 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 Division 03 Section "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 mixed with potable water according to manufacturer's written instructions.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

2.4 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic-welded type.
2. Grounding Rods: Copper-clad steel.

a. Size: 5/8 by 96 inches.

2.5 DECORATIVE METALLIC-COATED STEEL TUBULAR PICKET FENCES

A. Decorative Metallic-Coated Steel Tubular Picket Fences: Comply with ASTM F 2408, for light industrial (commercial) application (class) unless otherwise indicated.

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. Basis-of-Design Product: Subject to compliance with requirements, provide Arete, Flat top fence with picket bottom by Xcel Fence or approved equal.

B. Posts:

1. End and Corner Posts: 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.

C. Post Caps: Aluminum castings.

D. Rails: Square tubes.

1. Size: 1-1/2 by 1-1/2 inches.
2. Metal and Thickness: 0.079-inch nominal-thickness, metallic-coated steel sheet or 0.075-inch nominal-thickness, uncoated steel sheet, hot-dip galvanized after fabrication.

E. Pickets: Square tubes.

1. Terminate tops of pickets at top rail for flush top appearance.
2. Picket Spacing: 4 inches clear, maximum.

F. Fasteners: Manufacturer's standard concealed fastening system.

G. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

H. Finish: Powder coating.

2.6 STEEL FINISHES

A. Surface Preparation: Clean surfaces according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

B. Powder Coating: Immediately after cleaning, apply 2-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils. Comply with coating manufacturer's written instructions.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

C. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that will be exposed after assembly and installation, and to concealed surfaces.

D. Shop-Painted Finish: Comply with Division 09 Section "High-Performance Coatings."

E. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated 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.

1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

PART 3 - EXECUTION

3.1 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.

3.2 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 Division 01 Section "Execution"

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post 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.

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post.
    b. Concealed Concrete: Top 2 inches below grade to allow covering with surface material. Slope top surface of concrete to drain water away from post.

3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.

3.4 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:

1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.

    a. Gates and Other Fence Openings: Ground fence on each side of opening.

        1) Bond metal gates to gate posts.
        2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.5 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

END OF SECTION 323119

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SECTION 323150 - SITE SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Traffic control signage. Signs shall be constructed of aluminum sheeting and shall be reflectorized.
   2. Signage furnished and installed per drawings and in accordance with the current edition of the Manual for Uniform Traffic Control Design (MUTCD).

1.3 SUBMITTALS

A. See Section 013300 – Project Management and Coordination for submittal procedures.

B. Product Data: Provide Manufacturer's (catalog) product information.

C. Provide Shop drawings for review and approval which indicate graphic features and font style and size of signage and location where signage is to be installed.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years experience.

1.5 PROJECT CONDITIONS

A. Coordinate sign installation with size, location and installation of service utilities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Best Sign Systems

B. ASI Sign Systems Inc.

C. Charleston Industries, Inc.

D. Substitutions under provisions of Section 016000.

2.2 MATERIALS

A. Sheet aluminum shall be 6060-T6 Alloy, .080” thick.

B. Reflective sign facing shall consist of spherical lens elements either embedded within a transparent plastic or adhered to a synthetic resin and encapsulated by a transparent plastic.

C. Post shall be perforated 2” x 2” galvanized steel post, square section. Provide caps where detailed.

D. Signs and posts shall be assembled with 5/16” x 3-1/4” galvanized machine screws and 1” O.D. nylon washers, locknuts with nylon inserts, two screws per sign.

E. Galvanized steel sign post sockets shall be provided which fit the sign post profile and permit replacement of damaged sign posts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that the finish grade level has been determined for signage location prior to installation.

3.2 INSTALLATION

A. Traffic sign post sockets shall have 3’-0” embedded below the finish site grade.
   1. Sign post sockets shall be cast into Portland cement concrete, the surface finished to form a 12” diameter cap that directs water away from the post, post sockets installed in Portland cement concrete paving areas shall be installed with similar detail created during concrete placement and finishing.

B. Install sign posts plumb, signs level. Make corrections if required at direction of Landscape Architect.

3.3 ERECTION TOLERANCES

A. Maximum Variation from Plumb: ¼”.

END OF SECTION 323150

SECTION 323190 - FLAGPOLE

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes
   1. Tapered aluminum flagpole, ground mounted.
   2. 5'x 8' United States of America Flag.

1.2 RELATED SECTIONS

A. Concrete base and foundation construction.

1.3 REFERENCES

A. AASHTO M-36 - Corrugated Metal Culvert Pipe.
B. ASTM A53 - Pipe, steel, black and Hot-Dipped, Zinc Coated, Welded and Seamless.
C. ASTM A123 - Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.

1.4 PERFORMANCE REQUIREMENTS

A. Flagpole with United States of America Flag: Resistant without permanent deformation to 90 miles/hr; non-resonant, safety design factor of 2.5.

1.5 SUBMITTALS

A. See Section 013300 – Submittal Procedures.
B. Product Data: Provide data on pole, accessories and configurations.
C. Samples: Submit two samples 4 x 4 inch in size illustrating pole material, color and finish.
D. Maintenance Data to be included in maintenance manuals per Section 017823 – Operation and Maintenance.

1.6 DELIVERY, STORAGE AND HANDLING

A. Spiral wrap flagpole with protective covering and pack in protective shipping tubes or containers.
B. Protect flagpole and accessories from damage or moisture.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Flagpole shall be Model# ALWIN3056 with lock box from the American Flag Store, http://www.americanflagstore.com/alflagpoles/30ftintwinchaluminum.htm ; (888) 317-4594, or approved equal prior to bidding.

2.2 POLE MATERIALS

A. One-piece cone tapered seamless aluminum shaft, 6063-T6 alloy.

2.3 POLE CONFIGURATION

A. Outside Butt Diameter: 6 inches.

B. Outside Top Diameter: 3.5 inches.
C. Nominal Wall Thickness: .156 inch.
D. Nominal Height: 30 feet, measured from nominal ground elevation.
E. Flagpole: Ground-mounted type.
F. Flagpole Design: Cone tapered.
G. Halyard: Internal Halyard with internal winch assembly.

2.4 COMPONENTS AND ACCESSORIES

A. Finial: 5-inch gold anodized spun aluminum ball with flush seam.
B. Truck Assembly: Cast aluminum, revolving, stainless steel ball bearings, non-fouling.
C. Internal Concealed Cam-Action Cleat: With lockable access door.
D. Halyard: stainless steel aircraft cable; two chrome-plate swivel snap hooks with vinyl covers; neoprene covered counterweight, beaded retainer ring.
E. 5’x 8’ United States of America Flag.

2.5 OPERATOR

A. Hand Crank

2.6 MOUNTING COMPONENTS

A. Foundation Tube Sleeve: AASHTO M-36, corrugated (16) gage steel, galvanized, 3’-6” depth
B. Pole Base Attachment: Flush aluminum base with base cover.

2.7 FINISHES

A. Metal Surfaces in Contact with Concrete: Asphaltic paint.
B. Concealed Steel Surfaces: Prime painted.
C. Exposed to View Steel Surfaces: Field painted, color as selected (Natural Anodized).
D. Finial: Gold anodized finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site conditions under provisions of Division 1.
B. Verify that concrete foundation is ready to receive work and dimensions are as instructed by the manufacturer.

3.2 PREPARATION

A. Coat metal sleeve surfaces below grade and surfaces in contact with dissimilar materials with asphaltic paint.

3.3 INSTALLATION

A. Install flagpole, base assembly and fittings in accordance with manufacturer’s instructions.
B. Fill foundation tube sleeve with sand specified and compact.
C. Install foundation plate and centering wedges for flagpoles base set in concrete base and fasten.

3.4 ERECTION TOLERANCES

A. Maximum variation from Plumb: 1 inch (25mm).

3.5 ADJUSTING

A. Adjust operating devices so that halyard and flag function smoothly.

END OF SECTION 323190

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SECTION 323300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Trash Receptacles.
B. Bike Racks.
C. Benches.
D. Basketball Standards.
E. Tetherball Standards.
F. ‘Find the Correct Path’ Game Stencil.
G. ‘Mirror Me’ Game Stencil.
H. ‘Playground Circle Maze’ stencil.
I. ‘Snake Hopscotch (Letters)’ Stencil.
J. ‘Solar System Kit’ Stencil.
K. ‘Moon Boots Body Hop’ Outdoor Stencil.
L. Playground U.S.A. Map.
M. 9 Square In The Air.
N. Gaga Ball.

1.2 REFERENCES

A. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2000.
B. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2000.
C. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2000.
D. ASTM A 325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric); 2000.
E. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2000.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.
B. Product Data: Manufacturer's data sheets on each product specified, including detailed installation diagrams and recommended installation methods.
C. Selection Samples: For each product specified, two complete sets of chips representing manufacturer's full range of colors and finishes.

1.4 QUALITY ASSURANCE

A. Furnish paint for touch-up as required
B. Install pre-manufactured items, poured-in-place or pre-cast items, and all related materials required to complete the work indicated on the drawings and/or specified.
C. Substitutions: The intent of these specifications is to describe pre-manufactured items of minimum acceptability with regard to materials, construction, size, configuration, and finish. Substitutions will be accepted under provisions and shall be compatible with overall design

theme.

D. Materials Inspection: The Contractor shall inspect all items upon delivery to ensure no damage to material or finish. Minor repairs and/or touch up shall be accepted only upon prior authorization form the Architect and shall conform, at minimum, to manufacturer's standard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS- NOT USED

2.2 MATERIALS

A. Steel Structural Supports:
   1. Steel Plate: ASTM A 283/A 283M.
   2. Steel Pipe: ASTM A 53, Grade B Schedule 40, hot-dip galvanized finish.
   3. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M).

B. Welding Materials: AWS D1.1; type required for materials being welded.

2.3 SITE FURNISHINGS

A. Trash Receptacles:
32 Gallon Trash Receptacle by Wabash Valley, Inc., diamond pattern with Plastisol coating finish, or approved equal. Install with flat lid option. Model no. LR301D http://wabashvalley.com/ . Quantity: Nine. Color: By Architect.

B. Bike Rack: Dero Bike Rack Company: Product; Model No. Helix Rack, Bike Rack with powder coat finish. http://www.dero.com/ or approved equal. Quantity: Four. Color: By Architect.

C. Bench: Dumor Site Furnishings 6’ Backless Cast Bench, Steel Seat with powder coat finish. Model no. 191-60. https://www.dumor.com/ or approved equal. Quantity: Twelve. Color: By Architect.

D. Exterior Basketball Standards, Backboards and Goals
   1. Model – “Bison” PR98U-BK Adjustable Ultimate Basketball Package, with BA47 42”x60” rectangle steel backboard, BA39U super heavy-duty double rim goal and BA870, 6” square pole with 60” clearance. Bison, Inc. @ 1-800-247-7668, http://www.bisoninc.com/

E. Tetherball: Model TB100 In-Ground Tetherball Set, from Bison, Inc. or approved equal, http://www.bisoninc.com/ .

F. ‘Find the Correct Path’ Game Stencil by Fastline Striping Systems, http://fastline.net, 1-800-565-1564, or approved equal. Contractor shall provide One additional stencil to school district personnel after project completion.

G. ‘Mirror Me’ Game Stencil by Fastline Striping Systems, http://fastline.net, 1-800-565-1564, or approved equal. Contractor shall provide One additional stencil to school district personnel after project completion.

H. ‘Playground Circle Maze’ stencil, 24 x 24, by Fastline Striping Systems, http://fastline.net, 1-800-565-1564, or approved equal. Contractor shall provide One additional stencil to school district personnel after project completion.

I. ‘Snake Hopscotch (Letters)’ Stencil, 4’-2” x 21’-3”, by Fastline Striping Systems, http://fastline.net, 1-800-565-1564, or approved equal. Contractor shall provide One additional stencil to school district personnel after project completion.

J. ‘Solar System Kit’ Stencil, 19’ x 9’-4”, by Fastline Striping Systems, http://fastline.net, 1-800-565-1564, or approved equal. Contractor shall provide One additional stencil to school district personnel after project completion.

K. ‘Moon Boots Body Hop’ Outdoor Stencil by The Sensory Path, http://thesensorypath.com, 1-662-607-0448 or approved equal. Contractor shall provide One additional stencil to school district personnel after project completion.

L. Playground U.S.A. Map:
Education Technology Group, Playground U.S.A. Color Map (25’x 35’), 100% Acrylic paint, or approved equal. Install per manufacturer’s recommendations. Contact at http://www.et-group.com/maps.htm_ or (985) 789-1029 or (504) 722-3739. Contractor shall provide One additional stencil to school district personnel after project completion.

M. ‘9 Square In The Air, Playground Edition’. Surface Mount. By 9 Square In The Air, http://9squareintheair.com, 1-877-672-3938, or approved equal. Color: By Architect.

N. Gaga Ball:
1. 20’ Octagon 30H with ADA Doorway Kit, wall top cover corner brackets and 11x17 metal rules sign.
2. All boards shall be structural composite boards (recycled plastic lumber HDPE) by Coach Cliffs Gaga Ball Pits, or approved equal. Submit full range of colors to Architect for selection (Tier 1-4). Coach Cliff’s Gaga Ball Pits, 1-877-266-8426, www.gagaballpits.com.
3. Manufacturer’s standard painted finish on all hardware: Color to be selected at the time of submittals from manufacturer’s standard colors.
4. Installation per manufacturer’s written installation procedures and details. Submit shop drawing for approval.

2.4 FABRICATION

A. Shop assemble site furnishings for delivery to site in units easily handled and to permit shipment without disassembly.

2.5 ACCESSORIES

A. Provide all anchorage devices and materials required for a complete installation.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.
B. If substrate preparation is the responsibility of another installer, notify Landscape Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.3 ADJUSTING

A. Upon completion of the installation of site furnishings, check each items and verify that all equipment is properly installed; verify that all trim is in place; adjust all components as necessary to ensure proper operation; remove all labels from equipment.
B. Make necessary adjustments for safe, efficient and smooth operation.

3.4 CLEANING

A. Remove all packing materials from job site.
B. Clean or restore marred surfaces.

3.5 PROTECTION

A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products after Substantial Completion.

END OF SECTION 323300

SECTION 328400 - LANDSCAPE IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Pipe and fittings, valves, sprinkler heads, accessories, and connections to water source.
   2. Control system.
B. System Description
   1. Electric solenoid controlled automatic underground irrigation system.
C. Related Sections
   1. Division 16 Sections for electrical power materials and installations.

1.2 DEFINITIONS

A. Pipe sizes used in this Section are nominal pipe size (NPS) in inches. Tube sizes are Standard size in inches.
B. Pressure Piping Main Line: Piping downstream from supply piping to and including control valves. Piping is under irrigation system pressure. Piping in this category includes backflow preventers.
C. Circuit Piping Lateral Lines: Piping downstream from control valves to irrigation system sprinklers. Piping is under pressure (less than pressure piping) during flow.
D. Control Valve: Automatic (electrically operated) valve for control water flow to irrigation system zone.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Location of Sprinklers and Devices: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards.
B. Minimum Water Coverage: Not less than:
   1. Turf Areas: 100 percent.
   2. Other Planting Areas: 100 percent.
C. All flow velocities, within the entire irrigation system, shall not exceed 5 feet per second.

1.4 SUBMITTALS

A. Product data including pressure rating, rated capacity, settings, and electrical data of selected models for the following:
   1. Backflow preventers, including test equipment.
   2. Valves, including general-duty, underground, automatic control, and quick-coupler types, isolation and valve boxes.
   3. Sprinklers.
   4. Irrigation Controller, including controller wiring diagrams.
   5. Wiring.
   6. Irrigation system record drawings.
   7. Pipe fittings.

B. Wiring diagrams for electrical controllers, valves, and devices. Valve numbers shall reflect station numbers within the controller and shall be noted on the as-builts.

C. Maintenance data for inclusion in "Operating and Maintenance Manual" specified in Division 1 Section "Contract Closeout" for the following:

1. Seasonal activities of start-up, shut-down and winterization, including blow-out operation of sprinkler system with compressed air.
2. Backflow preventers, including instructions for testing.
3. Automatic control valves.
4. Sprinklers.
5. Controllers.
6. Irrigation system record drawings.

1.5 QUALITY ASSURANCE

A. Comply with requirements of utility supplying water for prevention of backflow and backsiphonage. Comply with appropriated water rights.

B. Installer Qualifications: **(To be provided at time of bid opening):** Engage an experienced Installer with a minimum of five years experience and who has completed irrigation systems similar in material, design, and extent to that indicated for Projects that have resulted in construction with a record of successful in-service performance.

1. Professional Membership: Installer shall be a member in good standing of the Irrigation Association.
2. Experience: Company specializing in performing the work of this section with minimum five (5) years of documented experience and experience in the installation of a minimum of three (3) projects of similar nature and scope in addition to requirements in Division 01 Section "Quality Requirements.". The installer shall have at least one supervisor responsible for the project who is a Certified Irrigation Contractor as recognized by the Irrigation Association. The installer may be asked to provide references for verification of experience and quality of service.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time English speaking supervisor on the Project site when irrigation work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Irrigation Association:
   a. Certified Irrigation Technician.
   b. Certified Landscape Irrigation Auditor.
   c. Certified Irrigation Contractor.
   d. Certified Irrigation Water Manager.

C. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.

D. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.
1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. Product Options: Irrigation system piping, specialties, and accessories are based on specific types, manufacturers, and models indicated. Components with equal performance characteristics produced by other manufacturers may be considered, provided deviations in dimensions, operation, and other characteristics do not change design concept or intended performance as judged by the Landscape Architect. The burden of proof of product equality is on the Contractor. Any substitutions must be approved by the Architect in writing prior to installation per section 1.10.

1.6 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Verify that irrigation system piping may be installed in compliance with original design and referenced standards. Verify that pump and domestic supply perform as specified.

1.7 SEQUENCING AND SCHEDULING

A. Maintain uninterrupted water service to building during normal working hours. Arrange for temporary water shutoff with Owner.
B. Maintain Uninterrupted existing irrigation system during construction. Arrange for temporary water shutoff with owner. Provide alternate water source for irrigation if water is to be shut off for more than three (3) days.
C. Coordinate irrigation systems work with landscape work specified in “Plants” Section ".

1.8 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and label clearly describing contents.
   1. Quick Couplers: Furnish quantity of units equal to 2 percent of amount of each size installed.
   2. Sprinklers: Furnish quantity of units equal to 5 percent of amount of each type installed.
   3. Valve Keys: Furnish quantity of tee-handle units equal to 2 percent of amount of each type key-operated, control valve installed.
   4. Quick-Coupler Hose Swivels: Furnish one for each quick coupler installed.
   5. Quick-Coupler Operating Keys: Furnish one for each quick coupler installed.

1.9 IRRIGATION RECORD DRAWINGS

A. Record accurately, on one set of black and white prints of the site plan **(to be on site at all times during installation),** all installed work including both pressure and non-pressure lines and pipe sizes.
B. Upon completion of each increment of work, transfer all such information and dimensions to the print. The dimensions shall be recorded in a legible and workmanlike manner. Maintain as-built drawings on site at all times. Make all notes on drawing in pencil (no ball point pen). When the work has been completed, transfer all information from the field record print to a set of reproducible drawings.
C. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavements, etc.). Locations shown on as-built drawings shall be kept day to day as the project is being installed. All dimension text noted on drawings shall be 1/8 inch in size (minimum).
D. Show locations and depths of the following items:
   1. Point of connection, including Flow Sensor Assembly
   2. Routing of sprinkler pressure lines
   3. Gate valves
   4. Sprinkler control valves
   5. Quick coupling valves
   6. Routing of control wires, including Flow Sensor Assembly wires
   7. Sprinkler heads
   8. Other related equipment

1.10 SUBSTITUTIONS

A. Coordinate substitutions per Division One.
B. Substitutions to the specified equipment will be permitted with the express written approval of the Landscape Architect. Substitutions will be approved only when the substituted item is equivalent or better in quality and performance than the item originally specified. The final determination for "equivalents" rests with the Landscape Architect. Their decision shall be final and binding.

1.11 WARRANTY

A. Warranty system against defects of installation and material for a period of 1 year after final completion of the irrigation system. Guarantee shall also cover repair or damage to any part of the premises resulting from leaks or other defects in material, equipment and workmanship to the satisfaction of the Architect. Repairs, if required, shall be done promptly upon notification by the Owner, and, at no cost to the Owner.
B. As part of the warranty, the Contractor shall be responsible for deactivating and winterizing the system prior to the onset of the freezing season and for reactivating the system at the onset of the spring growing season; each event must be accomplished once during the warranty period. In the event the system is completed in a season when it will not be in use, the Contractor shall winterize the system upon completion of testing (and approval by the Landscape Architect) and reactivate the system in the spring. The Contractor shall SUBMIT a letter to the Landscape Architect certifying that the system was winterized and drained and indicate the date such action was accomplished. The Contractor shall be responsible for any damage resulting from failure to comply. Contractor shall instruct and demonstrate winterization and startup techniques for Owner.

PART 2 - PRODUCTS

2.1 SUMMARY

A. All materials used throughout the system shall be new, unused, and in perfect condition. Refer to the irrigation materials legend, notes, detail drawings and these specifications for specific equipment to be used. Equipment or materials installed or furnished without prior approval of the Architect may be rejected and the Contractor required to remove such materials from the site at his own expense.
B. Substitutions: Under provisions of Division 1 and 328400, paragraph 1.10.

2.2 BRASS PIPE AND ACCESSORIES

A. Pipe: ASTM B43, Schedule 40; domestic manufacture
B. Fittings: Medium brass, screwed, 125-pound class.

2.3 PLASTIC PIPE AND ACCESSORIES

A. Pipe
   1. Pipe walls shall be uniform, smooth, glossy, and free of interior or exterior extrusion marks; pre-belled or straight to receive solvent-weld couplings; 20 foot standard lengths.
   2. Pipe shall be marked with manufacturer's name, class of pipe, NSF seal, and date/shift of manufacturing run.
   3. PVC Pipe: ASTM D1785, D2241
B. Fittings: PVC - ASTM D2464, D2466.

C. Irrigation System Plastic Pipe
   1. Mainline: 3-inch pipe and larger: PVC class 200 with SDR21 rubber gasket fittings. 2 ½ inch pipe and smaller: PVC schedule 40 pipe with SDR21 solvent weld fittings.
   2. Laterals: 3-inch pipe and larger: PVC class 200 with SDR21 rubber gasket fittings. 2 ½ inch pipe and smaller: PVC schedule 40 pipe with SDR21 solvent weld fittings.
   3. Sleeving: ASTM D 1785, schedule 40, polyvinyl chloride (PVC) plastic pipe; ASTM D 2466, Schedule 40, PVC plastic, socket-type fittings; and solvent-cemented joints.
   4. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube materials specified below are used.
   5. Polyvinyl Chloride (PVC) Plastic Pipe: ASTM D 1785; PVC 1120, SDR 21, 200 psig (1380 kPa) minimum pressure rating, with plain ends. Schedule 40 upstream from controls, as noted on the drawings; schedule 40 downstream.

D. Pipe and Tube Fittings
   1. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube fitting materials specified below are used.
   2. Polyvinyl Chloride (PVC) Plastic Pipe Fittings: ASTM D 2464, Schedule 80, threaded.
   3. Polyvinyl Chloride (PVC) Plastic Pipe Fittings: ASTM D 2467, Schedule 40, socket-type.
   4. “Leemco” Push-on joint Ductile Fittings or approved equal: for all pipes 2 ½” and larger.
   5. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion. These devices are a combination of copper alloy and ferrous metal; threaded- and solder-end types, matching piping system materials.
      a. Dielectric Unions: Factory-fabricated, union assembly, designed for 250 psig (1725 kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B1.20.1.
      b. Transition Fittings: Manufactured assembly or fitting, with pressure rating at least equal to that of system and with ends.

2.4 JOINING MATERIALS

A. Solvent Cement: ASTM F 656 primer and ASTM D 2564 solvent cement in color other than orange.

2.5 VALVES

A. General: Valves are for general-duty and underground applications. Refer to "Valve Applications" Article for locations of various valve types specified in this Article. Refer to "Control Valves" Article for control valves and accessories.

2.6 CONTROL VALVES

A. Description: Manufacturer's standard control valves for circuits, of type and size indicated on Drawing, and as follows:
   1. Angle Valves: Bronze construction, non-rising stem, inside screw threaded ends and as noted on the Drawings.
   2. Automatic Control Valves: Diaphragm-type, normally closed, with manual flow adjustment, and operated by 24-volt-a.c. solenoid.

3. Quick-Couplers: Factory-fabricated, 2-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.
    a. Locking Top : Include vandal-resistant, locking feature with 2 matching keys.
4. Drain Valve: As noted on the Drawings.
5. Isolation Gate Valves: 150# gate valve, epoxy-coated, ductile iron, resilient wedge valve with non-rising stem and inside screw with threaded ends. Mechanical joint or push-on. "Waterous", "American Flow Control" or "Nibco" gate valves or approved equal prior to bidding. Size to match line size. Install in valve box, size adequate for maintenance access. Minimum 15" x 21".
6. "Air Release Valve: 2" air release valve from "Crispin", "Ames", or "Waterman", install in valve box.
7. Master Valve/ Flow Sensor Assembly: Netafim Hydrometer, size to match main line, or approved equal.
8. "Leemco" Ductile Iron Lateral Connection System or approved equal.

B. Control Valve Boxes and Cover: Thermo-plastic valve boxes with lockable, snap-top lids. Size as required for application or as noted on drawings, maximum one (1) valve per box. All boxes shall have purple lids labeled "DO NOT DRINK".
1. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3 inches (75 mm) maximum to 3/4 inch (19 mm) minimum. Cover gravel with layer of filter fabric.

C. Service Boxes for Key-Operated Control Valves: Size and type as shown on Drawings.
1. Include valve key, 48 inches (915 mm) long with tee handle and key end to fit valve.

D Irrigation System Controls
1. Controller: As noted on the Drawings. All control wiring that is above ground shall be installed in conduit. Electrical wiring shall be installed according to local code. Provide surge protectors install controllers.
2. Controller Housing: Weatherproof, watertight, with lockable access door.
3. Valves: Electric Solenoid type and size of control valves as noted on the Drawings, including required fittings and accessories.
4. Wire: Color coded, copper conductor direct burial, UF-UL listed as noted on the drawings.

2.7 SPRINKLERS

A. Description: Manufacturer's standard sprinklers designed to provide uniform coverage over entire area of spray shown on Drawings at available water pressure, as follows:
1. Housings: Plastic, except where material is specified.
2. Pop-Up, Spray: Fixed pattern, with screw-type flow adjustment and stainless-steel retraction spring.
3. Pop-Up, Rotary Spray: Gear drive, full-circle and adjustable part-circle type.
4. All sprinkler heads shall have purple non-potable water caps.

2.8 AUTOMATIC CONTROL SYSTEM

A. Description: Low-voltage controller system, made for control of irrigation system automatic control valves. Controller operates on 120 volts a.c. building power system, provides 24 volts a.c. power to control valves, and includes stations for at least the number of control valves indicated. Size and type as shown on Drawing.

B. Control Enclosures: Weatherproof enclosure with locking cover and 2 matching keys. Enclosure construction complies with NFPA 70 and NEMA 250, Type 4, and includes provision for grounding. All control wiring that is above ground shall be installed in conduit. Electrical wiring shall be installed according to local code. Provide surge protectors in all controllers.
   1. AG 240 V Surge Arrester: As noted on the drawing. Install in approved J-box next to controller. Install per manufacturer recommendations.
   2. Stainless Steel Wall Mounted Enclosure by Strong Box Item #B-16SSW or approved equal.

C. Transformer: Internal-type, and suitable for converting 120 volts a.c. building power to 24 volts a.c. power.

D. Controller Stations for Automatic Control Valves: Each station is variable from approximately 1 to 60 minutes. Include switch for manual or automatic operation of each station.

E. Timing Device: Adjustable, 24-hour, 14-day clock to operate any time of day. Include provision for the following settings:
   1. Setting to skip operation any day in timer period.
   2. Setting for operation every other day.
   3. Settings for operation 2 or more times daily.
   4. Include manual or semi-automatic operation without disturbing preset automatic operation.
   5. Provide NI-CAD battery and trickle charger to automatically power the timing device during power outages.

F. Wiring: UL 493, solid copper conductor, insulated cable, suitable for direct burial.
   1. Splicing Materials: Pressure-sensitive, waterproof, thermoplastic wire connectors and other materials required to make specified connections. Locate all splice within valve boxes.
   2. Decoder Wire to be size # 14 not to exceed 10,000 Linear feet before sizing up to #12 wire.

G. Communication Cable.
   1. All cable required for the 2-wire paths and from Controller to flow sensor shall be REA Pe-39, 19 gauge, conductor-solid annealed uncoated copper conforming to ASTM-B3; insulated with expanded polyolefin surrounded by solid polymer to ensure low loss long transmission capability. Communication cable shall be of a type and size manufactured for use with Baseline hardware and approved by Baseline for installation of this type.
   2. Cable for the 2-wire paths shall be installed with no underground splices. All cable shall be laid in trenches (“pulling-in” of cable for installation without trenching will not be allowed unless pre-approved by the Landscape Architect) and shall be carefully back-filled to avoid any damages to the cable insulation or cable conductors themselves. In rocky areas, the trench shall have a 6” layer of clean sand on the bottom before the cable is laid into the trench and back-filled. If rocky back-fill is being used, the cable shall have an additional 6” layer of sand on top of it before back-filling is started. The cable shall have a minimum of 18” of cover.
   3. All 2-wire shall be installed in a PVC schedule 40 conduit and a sleeve (where passed under paving, walls or any other paved areas) of proper size required for the number of cables to be placed in it. The 2-wire path is permitted to be laid in the same trench with the 117 VAC cable as much as possible by laying each in opposite sides of the trench.

2.9 VALVE BOXES

A. Carson Industries or approved equal green body with locking lid. Standard rectangular box, model L series 1220-12 with T-cover, for all electrical control valves, 1419-12B. 10" round box for all mainline ball valves, gate valves, and hose bibs. All boxes shall have purple lids labeled "Do not Drink".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Investigate and determine available water supply water pressure and flow characteristics.
B. Insure that new pump station is providing necessary performance. Notify Landscape Architect of any deviations from design performance.

3.2 PREPARATION

A. Set stakes to identify proposed sprinkler locations. Obtain Irrigation Designer's approval before excavation.

3.3 PAVING WORK

A. Install piping in sleeves where crossing sidewalks, roadways, parking lots, playgrounds and railroads.
   1. Install piping sleeves by boring or jacking under existing paving, where possible.
   2. If it is necessary to cut pavement sections, pavement shall be replaced in cut areas per I.S.P.W.C. standards and requirements.

3.4 PIPING APPLICATIONS

A. Refer to Part 2 of this Section for detailed specifications for pipe and fittings products listed below. Use pipe, tube, fittings, and joining methods according to the following applications. Piping in pits and aboveground may be joined with flanges instead of joints indicated.
B. Use pipe, tube, fittings, and joining methods according to the following applications.
C. Pressure Piping Underground: Use the following:
   1. 2 ½ Inches (DN 80) and Smaller: ASTM D 2467, Schedule 40, PVC plastic, socket-type pipe fittings; and solvent-cemented joints.
   2. 3-Inches (DN 100) and Larger: ASTM D 2241, SDR 21 rubber gasketed Class 200, polyvinyl chloride (PVC) plastic pipe; ASTM A 536 push on ductile iron fittings.
D. Circuit Piping: Use the following:
   1. All Sizes: ASTM D 2241, ASTM D 2466, Schedule 40, polyvinyl chloride (PVC) plastic, socket-type fittings; and solvent-cemented joints.
E. Sleeves: ASTM D 2466, Schedule 40, polyvinyl chloride (PVC) PVC plastic, socket-type fittings; and solvent-cemented joints. Sleeve diameter shall be two sizes larger than pipe installed in sleeve with minimum sleeve size being 4". Extend sleeves 12" minimum beyond walk or pavement edge.

3.5 JOINT CONSTRUCTION

A. Threaded Joints: Thread pipes with tapered pipe threads according to ASME B1.20.1, apply tape or joint compound, and apply wrench to valve ends into which pipes are being threaded.

B. Polyvinyl Chloride (PVC) Piping Solvent-Cemented Joints: Construct joints according to ASTM D 2672 and ASTM D 2855.
   1. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling when joining plastic pipe and fittings with solvent cements.
C. Dissimilar Materials Piping Joints: Construct joints using adapters that are compatible with both piping materials, outside diameters, and system working pressure. Refer to "Piping Systems - Common Requirements" Article for joining dissimilar metal piping.
D. Provide “Leemco” joint restraints at all gasket fittings where a change of direction occurs, or approved equal. Install all joint restraints per manufacturer’s recommendations.

3.6 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, and in other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
B. Install components having pressure rating equal to or greater than system operating pressure.
C. Install piping free of sags and bends. Deflections angles shall not exceed manufacturer’s recommendations.
D. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
E. Install fittings for changes in direction and branch connections.
F. Piping Connections: Except as otherwise indicated make piping connections as specified below.
   1. Install unions, in piping 2 inches (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having 2-inch (DN 50) or smaller threaded pipe connection.
   2. Install flanges, in piping 2-1/2 inches (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
   3. Install dielectric fittings to connect piping of dissimilar metals.

3.7 PIPING INSTALLATION

A. Install underground polyvinyl chloride (PVC) plastic pipe according to ASTM D 2774.
B. Lay piping on solid subbase, uniformly sloped without humps or depressions.
   1. Install polyvinyl chloride (PVC) plastic pipe in dry weather when temperature is above 40 deg F (4 deg C). Allow joints to cure at least 24 hours at temperature above 40 deg F (4 deg C) before testing, unless otherwise recommended by manufacturer.
C. Minimum Cover: Provide following minimum cover over top of buried piping:
   1. Pressure Piping: 18 inches.
   2. Circuit Piping: 12 inches.
   3. Sleeves: 24 inches.
D. Boring
   1. Locations: Boring shall be used to route pipe, wiring or both under concrete structures such as walks or curbs where trenching is impractical. Sleeves shall be installed in all bored holes.
   2. Method: Boring shall be accomplished with a drill, auger, water jet, or any other instrument approved by the Owner’s Representative capable of producing a precise hole. Boring shall not disturb overlaying structures or cause settlement and damage to those structures. Repair or replace any pavement damaged during boring procedures.

E. Install piping under sidewalks and paving in sleeves.

F. Back-filling

1. Inspection: The trenching shall not be backfilled until inspection and pressure testing has been completed and the pipe installation, including the grade, alignment and jointing has been found to be in compliance with the requirements of the plans and specifications.
2. Around and Over Pipe:
   a. Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than 1/2 inch shall be used in backfilling around and over the installed pipe.
   b. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The Contractor may at his option and own expense provide an acceptable imported material.
   c. Backfill material shall be carefully deposited around and over the pipe in layers not more than 6 inches thick, loose measurement, wetted to optimum moisture content and uniformly compacted to at least 95 percent of the maximum density obtainable at optimum moisture content as determined by AASHTO T99 Method A or D (latest revision), until the pipe has a cover depth of at least 12 inches.
3. Remainder of Trench Backfill:
   a. The remaining depth of the trench shall be backfilled to existing finish grade, with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.
   b. Contractor shall be required to repair any settling problems which occur in the trench locations for the duration of the warranty period.

G. Pipe fittings

1. All piping 3” diameter or greater shall use “Leemco” ductile iron push on type fittings. Provide “Leemco” joint restraints at all gasket fittings where change of direction occurs. See drawings for details.
2. All piping less than 3” diameter shall use Schedule 40 socket type fittings.

3.8 VALVE APPLICATIONS

A. **Rainbird PESB-R** with adjustable Dial pressure regulating module, size per plans.

3.9 VALVE INSTALLATION

A. Valves: Install underground valves in valve boxes as shown on Drawings.

B. Control Valves: Install in valve control valve boxes, arranged for easy adjustment and removal. Install union on downstream side. Maximum (1) valve per valve box.

C. Place 6 inches minimum of gravel below control valves for drainage. Maintain 4 inches minimum between bottom of valves and top of gravel. Place filter fabric barrier between gravel and valves. Valve box shall be free of dirt and debris.

3.10 SPRINKLER INSTALLATION

A. Sprinklers: Flush circuit piping with full head of water and install sprinklers after hydrostatic test is completed.

1. Install lawn sprinklers at manufacturer's recommended heights.
2. Install shrubbery sprinklers at heights indicated.

3. Locate part-circle sprinklers to maintain a minimum distance of 12 inches from walls and 2 inches (50 mm) from other boundaries, unless otherwise indicated.
4. Sprinkler Head Risers: Rotor pop-up sprinkler shall have an adjustable riser assembly (triple swing joint Rain Bird SA Series or approved equal). Stationary spray pop-up heads or shrubs spray heads shall have an adjustable riser assembly (triple swing joint) or low-density polyethylene flex pipe as shown on Drawings details. Triple swing joint fittings shall be of Schedule 80 PVC. Flex pipe shall be 12 inch long minimum and 18 inch maximum linear low-density polyethylene pipe with spiral barb fittings and 90 degree ell as shown on details on Drawing.
5. Quick coupling valves shall be installed with an adjustable riser assembly (triple swing joint) and a Leemco quick coupler stabilizer, size as necessary.

3.11 AUTOMATIC CONTROL SYSTEM INSTALLATION

A. Install controllers and controller pedestal according to manufacturer's written instructions and as indicated.
B. Install control wiring in same trench with piping. Where wiring leaves from piping trenches, install wiring in conduits.
C. Install control wiring in accordance with Specifications. Provide 10 inches expansion coil At each valve to which controls are connected, and at 100 foot intervals. Bury wire beside mainline pipe. Where wire leaves pipe, enclose in conduit. Use waterproof wire connectors. Use white or gray color for common wires and black or red colors for all other wires. No control wires shall be placed in thrust blocks. Locate wires on opposite side of thrust blocks.

3.12 TRENCHING

A. Trench Size:
1. Minimum Depth: as necessary to provide 18” of cover for mainline, sleeves, and wires.
2. Minimum Depth: as necessary to provide 12” of cover for all lateral lines.
3. Minimum Width: 4-inch pipe and larger – 12 inches.
4. Minimum Width: 3-inch pipe and smaller – 9 inches.
B. Trench to accommodate grade changes and slope to drains.
C. Maintain trenches free of debris, material, or obstructions that may damage pipe.

3.13 CONNECTIONS

A. Connect piping to sprinklers, devices, valves, control valves, specialties, and accessories.
B. Connect water supplies to irrigation systems. Include reduced pressure back-flow preventers on potable water supplies.
C. Electrical Connections: Connect to power source, controllers, and automatic control valves.

3.14 FIELD QUALITY CONTROL

A. Testing: Perform test of piping and valves before back-filling trenches. Piping may be tested in sections to expedite work. Owner’s representative must be present for testing.
1. Make all necessary provisions for thoroughly bleeding the line of air and debris.
2. Before testing, fill the line with water for a period of at least 24 hours.
3. **After valves have been installed, test all live water lines, (main line and lateral lines) for leaks at a pressure of <u>100 psi for a period of one hour</u>, with all couplings exposed and with all pipe sections center loaded.**
4. Furnish all necessary testing equipment and personnel.
5. Correct all leaks and retest until acceptance by the Landscape Architect.

B. Field inspection and testing will be performed under provisions of Division 1.

C. Installer's Field Service
   1. Prepare and start systems under provisions of Division 1.
   2. Provide one complete spring start-up and a fall shutdown, including winterization to blow out entire system with compressed air.
D. Adjust work under provisions of Division 1.
C. Change and/or adjust head types for full water coverage as directed.
D. Adjust nozzle spray pattern as required to avoid water spray on building walls, roads or sidewalks.
E. Have all backflow preventers tested by appropriate agency.

3.15 CLEANING AND ADJUSTING

A. Flush dirt and debris from piping before installing sprinklers and other devices.
B. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
C. Carefully adjust lawn sprinklers so they will be flush with, or not more than 2-inch (13 mm) above, finish grade after completion of landscape work. Adjust so that sprinklers do not spray on buildings or walls.
D. Adjust settings of controllers and automatic control valves to insure proper watering of all landscaping.

3.16 COMMISSIONING

A. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturers, proceed as follows:
   1. Verify that specialty valves and their accessories have been installed correctly and operate correctly.
   2. Verify that specified tests of piping are complete.
   3. Check that sprinklers and devices are correct type.
   4. Check that damaged sprinklers and devices have been replaced with new materials.
   5. Check that potable water supplies have correct type back-flow preventers.
   6. Energize circuits to electrical equipment and devices.
   7. Adjust operating controls.
B. Operational Testing: Perform operational testing after hydrostatic testing is completed, backfill is in place, and sprinklers are adjusted to final position.

3.17 DEMONSTRATION

A Provide irrigation system demonstration under provisions of Division 1.
B. Demonstrate to Owner: that system meets coverage requirements and that automatic control functions properly.
C. Demonstrate to Owner's maintenance personnel operation of equipment, sprinklers, specialties, and accessories. Review operating and maintenance information including start up and winterization procedures.
D. Provide 7 days written notice in advance of demonstration.

END OF SECTION 328400

SECTION 328500 - LANDSCAPE GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Final grade topsoil for finish landscaping.

B. Related Sections

1. Specification Section 311000: Site Clearing.
2. Specification Section 312000: Earthmoving

1.2 SUBMITTALS

A. Submit under provisions of Division 1.

1.4 QUALITY ASSURANCE

A. Provide analysis of existing and imported topsoil fill under provisions of Division 1.

B. Topsoil Analysis: Furnish a soil analysis if existing and imported topsoil made by a qualified independent soil-testing agency stating percentages of organic matter, inorganic matter (silt, clay and sand), deleterious material, pH, and mineral and plant-nutrient content of topsoil.

C. Report suitability of topsoil for growth of applicable planting material. Contractor shall state in writing the recommended quantities of nitrogen, phosphorus, and potash nutrients and any limestone, aluminum, sulfate, or other soil amendments to be added to produce topsoil meeting the requirements listed in this section. Soil amendment quantities are called out in Sections 329200 and 329300 but are for bid purposes only. The results of the soils tests as reviewed by the Landscape Architect determine the proper amendments.

D. All finish grades shall be approved by Landscape Architect prior to landscape installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS - NOT USED.

2.2 MATERIALS – NOT USED

2.3 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, 2.5% organic material minimum, free of stones 1 inch (25mm) or larger in any dimension, and other extraneous materials harmful to plant growth.

1. Existing Topsoil Source: Reuse surface topsoil stockpiled on the site. Verify suitability of surface soil to produce topsoil meeting requirements and amend when necessary. Approved by Landscape Architect. Supplement with imported topsoil when quantities are insufficient. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.
2. Imported Topsoil Source: Import topsoil from off-site sources. Provide new topsoil that is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 1 inch in any dimension, and other extraneous or toxic matter harmful to plant growth.
    a. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at project site. Obtain topsoil only from naturally, well-drained site where topsoil occurs in a depth of not less than four inches. Do not obtain from bogs or marshes.
    b. Representative samples shall be tested for acidity, fertility and general texture by a recognized commercial or government agency and copies of the testing agency's findings and recommendations shall be furnished to the Architect's representative by the contractor. No topsoil shall be delivered in a frozen or muddy condition. Acidity/alkalinity range – pH 5.5 to 7.6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify trench backfilling have been inspected.

B. Verify substrate base has been contoured and compacted and topsoil has been placed to design grades per the plans.

C. Beginning work of this section means acceptance of rough grading, topsoil placement, and existing conditions.

3.2 PREPARATION

A. Substrate

1. Eliminate uneven areas and low spots.
2. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove subsoil contaminated with petroleum products.
3. Scarify subsurface to depth of 6 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil. Scarify on multiple passes in intersecting directions to break up, cut and mix subsurface to provide a homogenous mixture.

3.3 EXECUTION

A. Place topsoil in areas where required to obtain thickness as scheduled. Place topsoil during dry weather.

B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.

C. Finish grade of lawn or plant bed areas prior to planting shall be:

1. Seeded Areas – 3/4 inch below top of adjacent pavement of any kind.
2. Sodding Areas – 1½ inch below top of adjacent pavement of any kind.
3. Planter Bed Areas - 3 inches below top of adjacent pavement of any kind.

D. Remove roots, weeds, rocks, and foreign material while spreading, and remove from site.

E. Manually spread topsoil close to plant life and paving to prevent damage.

F. Lightly compact placed topsoil.

G. Remove surplus subsoil and topsoil from site.

H. Leave site clean and raked, ready to receive landscaping.

I. Tolerances

1. Top of Topsoil: Plus or minus ½ inch.

3.4 FIELD QUALITY CONTROL - NOT USED.

3.5 ADJUSTING - NOT USED.

3.6 CLEANING - NOT USED.

3.7 DEMONSTRATION - NOT USED.

3.8 PROTECTION

A. Protect landscaping and other features remaining as final work.

B. Protect existing structures, fences, sidewalks, and paving.

3.9 SCHEDULES

A. Compacted topsoil thickness at the following areas:

1. Seeded Grass: 12 inches.
2. Planter Beds: 18 inches.
3. Sod: 12 inches

END OF SECTION 328500

SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

B. Related Requirements:
   1. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
   2. Section 329300 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

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. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. 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.

J. 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."

K. 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. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. 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.

Q. USCC: U.S. Composting Council.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the **Project site prior to soil preparation**. Schedule preinstallation conference with the landscape architect.

1.5 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 and 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.

B. Samples: For each bulk-supplied material, **1-quart** volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.6 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.

1.7 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. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: **Engage** a qualified testing agency to perform preconstruction soil analyses on **imported soil**.

1. Notify Landscape 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.

1.9 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 C**ontractor in presence of the Architect** under the direction of the testing agency.

1. Number and Location of Samples: Minimum of **three** 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.
   b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of **SSSA NAPT NCR-13** 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.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.

12. Copper ppm.
13. Sodium ppm **and sodium absorption ratio**.
14. Soluble-salts ppm.
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

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained **and stockpiled on-site**; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Soil: 3 cubic yards per **1000 sq. ft.** per **6 inches** of soil depth.

C. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of **sandy loam** or **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 5.5 to 7** and minimum of **4** 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 1 **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: 3 cubic yards per **1000 sq. ft.** per **6 inches** of soil depth.

D. Planting-Soil Type: Manufactured soil consisting of manufacturer's basic **topsoil, sandy loam according to USDA textures,** blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials to produce viable planting soil.
1. Additional Properties of Manufacturer's Basic Soil before Amending: Soil reaction of **pH 5.5 to 7** and minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
2. Unacceptable Properties: Manufactured soil shall not contain 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 **5** percent by dry weight of the manufactured soil.

c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding **1 inch** in any dimension.

3. Blend manufacturer's basic soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   a. Ratio of Loose Compost to Soil: 3 cubic yards per **1000 sq. ft.** per **6 inches** of soil depth.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
3. Form: Provide lime in form of ground **dolomitic limestone or approved equal.**

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**.

2.3 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: **May include animal waste**.
2. Reaction: **pH of 5.5 to 7.**
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.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a **1/2-inch** sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of **maximum 5** dS/m.

C. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

1. Partially Decomposed Wood Derivatives: In lieu of shredded and composted wood derivatives, mix shredded and partially decomposed wood derivatives with ammonium nitrate at a minimum rate of **0.15 lb/cu. ft.** of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of **0.25 lb/cu. ft.** of loose sawdust or ground bark.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of **20** percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: **1 lb/1000 sq. ft.** of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 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.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of **6 inches** and stockpile until amended.

B. Unacceptable Materials: Clean soil of 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.

C. Unsuitable Materials: Clean soil to contain a maximum of **8** percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a **2-inch** sieve to remove large materials.

3.3 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 **12 inches**. Remove stones larger than **2 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 as **indicated on Drawings**, 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 and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

    a. Mix **lime and sulfur** with dry soil before mixing fertilizer.
    b. 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 **8 inches** in loose depth for material compacted by compaction equipment, and not more **6 inches** in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to **75** 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.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. 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 **2 inches** in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top **4 inches** of subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth **indicated on Drawings**, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply planting soil in lifts not exceeding **8 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 lift of planting soil to **75** 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.

3.5 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 **8 inches**. Remove stones larger than **2 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** 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.

3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply **compost component of planting-soil mix 6 inches of compost** 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.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections. Terra Enviro Consulting, Inc., 208-377-9293 or approved equal.

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. S pace 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.

3.8 PROTECTION

A. Protection Zone: Identify protection zones according to Section 015639 "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 over compacted, 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.

3.9 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 329113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Drill seeding
   2. Hydroseeding.
   3. Sodding.
   4. Erosion-control material(s).

B. Related Sections:

   1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
   2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
   3. Division 32 Section "Planting Irrigation " for turf irrigation.
   4. Division 32 Section "Plants" for border edgings.

C. References:
   1. FS O-F-241 - Fertilizers, Mixed, Commercial.
   2. ASPA (American Sod Producers Association) - Guideline Specifications to Sodding.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

J. Topsoil: Per specifications section 328500.

K. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, Brome Grass, Black Henbane, Buffalobur, Common Crupina, Dalmatian Toadflax, Diffuse Knapweed, Dyer's Woad, Eurasian Watermilfoil, Field Bindweed, Hoary Cress, joined Goatgrass, Leafy Spurge, Matgrass, Meadow Hawkweed, Meadow Knapweed, Milium, Musk Thistle, Orange Hawkweed, Perennial Pepperweed, Perennial Sowthistle, Poison Hemlock, Puncturevine, Purple Loosestrife, Russian Knapweed, Scotch Broom, Scotch Thistle, Silverleaf Nightshade, Skeletonleaf Bursage, Spotted Knapweed, Syrian Beancaper, Toothed Spurge, Yellow Starthistle, Yellow Toadflax, Russian Knapweed, Jointed Goatgrass, Skeletonleaf Bursage, Hoary cress, Musk thistle, Yellow Starthistle, Hayek, Rush Skeletonweed, Poison Hemlock, Toothed Spurge, Leafy Spurge, Orange hawkweed, Dumort, Black henbane, Dyer's Woad, Perennial pepperweed, Yellow Toadflax, Milium, Eurasian Watermilfoil, Matgrass, Tansy Ragwort

1.4 SUBMITTALS

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

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Submit sod certification for grass species and location of sod source.

D. Qualification Data: For qualified landscape Installer.

E. Product Certificates: For soil amendments and fertilizers, from manufacturer.

F. Material Test Reports: For existing native surface topsoil and imported or manufactured topsoil.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Include cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer and herbicide. Submit before expiration of required initial maintenance periods.

H. Seed Tabs: One tag for each seed mix used with date(s) of application.

I. Fertilizer Labels: One label for each mix with date(s) of applications.

J. Hydro-mulch Labels: One label with date(s) of application.

K. Hydro-mulch Tackifier Labels: One label with date(s) of application.

L. Soil Amendment samples.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Company specializing in manufacturing products specified in this section, with not less than three (3) years of documented experience.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
   1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
   2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of two representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
   3. Report suitability of tested soil for turf growth.
      a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Pre-installation Conference: Conduct conference at Project site prior to any turf installation. Contractor shall schedule conference with the landscape architect.

E. Obtain materials from same source throughout.

F. Contractor shall be responsible to provide proof of material delivery and installation.

1.6 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 conformance with state and federal laws, as applicable. The label shall show the variety of seed, the percentage of germination, purity and weed content.

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" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:
   1. Do not dump or store bulk materials near drainage facilities, 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 fertilizers, lime, and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

A. Planting Restrictions: Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

B. Planting Season: Seeding shall be accomplished in the fall prior to September 15th. If this is not accomplished, seeding shall be in the following spring after April 15.

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.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate work under provisions of Division 1.

B. Coordinate with installation of underground sprinkler system.

1.9 EXTENDED WARRANTY

A. Provide one-year warranty under provisions of Division 1. Warranty includes coverage for one continuous growing season; replace lawn (seed or sod) that is dead, unhealthy or in an unsightly condition.

1.10 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion of entire project.
   a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
   b. Seeded turf areas will not be accepted as substantial completion until a healthy, full, uniform stand of grass with no bare spots has been obtained.

2. Sodded Turf: 60 days from date of Substantial Completion of entire project.

B. Initial Dryland Grass Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 60 days from date of Substantial Completion.

C. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
   1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
   2. Apply herbicides to control weed growth in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

D. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn 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 lawn at a minimum rate of 1½ inch per week.

E. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 30 percent of grass height. Remove no more than 30 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Remove excess clippings after mowing. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the grass height at 2.5inches

F. Lawn Fertilization: Apply fertilizer at intervals specified.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows:

C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. Sun and Partial Shade: NoNet Spreading-type, Rhizomatous Turf Type Tall Fescue from Jacklin Seeds, or approved equal. Contractor shall submit seed mix for review and approval prior to installation.
   2. Seed shall be provided from and mixed by a certified dealer. Seed mixture shall be labeled with manufacturer's guaranteed analysis, germination rate and purity rate.
   3. Apply at manufacturer's recommended application rate.

2.2 TURF GRASS 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, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. Sun and Partial Shade: NoNet Spreading-type, Rhizomatous Turf Type Tall Fescue from Jacklin Seeds, or approved equal. Contractor shall submit seed mix for review and approval prior to installation."

2.3 DRYLAND SEED

A. Grass Seed: Install at 25 lbs / acre. Fresh, clean, pure live, and dry new seed, of mixed species as follows (or approved equal):
   1. 7.6% Bluebunch Wheatgrass
   2. 9.8% Thickspike Wheatgrass
   3. 9.45% Ephraim Wheatgrass
   4. 5.3% Covar Sheep Fescue
   5. 9.0% Thurber Needle Grass
   6. 9.0% Great Basin Wild rye
   7. 6.3% Indian Rice Grass
   8. 5.25% Western Yarrow
   9. 5.0% Canby Bluegrass
   10. 5.3% Lewis Blue flax
   11. 9.0% Sainfoin
   12. 2.0% Farewell To Spring
   13. 17.0% Steptoe Barley

B. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.4 SOIL AMENDMENTS

A. Compost: (Apply at 3 cu. yds. per 1000 sq. ft.) Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.5 FERTILIZERS

A. Commercial Slow Release 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.
   2. Initial Application (two weeks after seeding, assumes fall planting) at 5 lbs/1000 sq. ft:
      a. 16 percent Nitrogen.
      b. 16 percent Phosphorus.
      c. 16 percent Potassium.
      d. Micronutrients
      e. 60 percent slow release nitrogen.
   3. Spring Fertilization: (April 1) at 7 lbs/1000 sq. ft.
      a. 30 percent Nitrogen.
      b. 6 percent Phosphorus.
      c. 12 percent Potassium
      d. 50 percent slow release nitrogen.
   4. Summer Application: (June 1) at 7 lbs/1000 sq. ft.
      a. 30 percent Nitrogen.
      b. 6 percent Phosphorus.
      c. 12 percent Potassium
      d. 50 percent slow release nitrogen.
   5. Fall Application: (August 15) at 7 lbs/1000 sq. ft.
      a. 18 percent Nitrogen.
      b. 3 percent Phosphorus.
      c. 18 percent Potassium
      d. 50 percent slow release nitrogen.

2.6 PLANTING SOILS

A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth. Mix ASTM D 5268 topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   1. Weight of Compost per 1000 sq. ft.: 3 cu. yds.
   2. Weight of Elemental Sulfur (90% S) per 1000 Sq. Ft.: 2 lbs.
   3. Weight of Commercial Fertilizer per 1000 Sq. Ft.: 5 lbs.
   4. Weight of Muriate of potash (00-00-60) per 1000 Sq. Ft.: 6.5 lbs.
   5. Weight of Monoammonium phosphate (11-52-00) per 1000 Sq. Ft.: 1.2 lbs

B. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

   1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1/2 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, 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 harmful to plant growth; free of

obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.7 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.8 PESTICIDES

A. General: Pesticide, registered and approved by 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 Non-Selective): 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 Non-Selective): Effective for controlling weed growth that has already germinated.

D. Weed Abatement: “Round-up” (contact herbicide) by Monsanto, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

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. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling 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 and which is too dusty.

5. Verify that prepared topsoil is ready to receive the work of this Section.
6. Beginning of installation means acceptance of existing site conditions.
7. All planting areas shall be weed free at the time of seed or sod installation.
8. Soil Tests: Per Landscape Grading specification section 328500. Prior to planting, amendments shall be added to correct for problems as noted by the soils report.

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 Landscape Architect and replace with new planting soil.

3.2 WEED ABATEMENT

A. All areas to be planted or hydroseeded shall have weed abatement operations performed on them prior to planting or hydroseeding.

B. Contractor shall spray all exposed weeds with “Round-up” (contact herbicide) or approved equal.

C. Do not water for at least seven (7) days. Remove exposed weeds from the site.

D. Contractor shall operate the automatic irrigation system for a period of fourteen (14) days. At conclusion of this watering period, discontinue watering for three to five (3-5) days.

E. Apply second application of “Round-up” to all exposed weeds. Apply in strict conformance with manufacturer’s specifications and instructions. Do not water for at least seven (7) days. Remove weeds from the site.

F. If any evidence of weed germination exists after two (2) applications, Contractor shall be directed to perform a third application.

G. At the time of planting and hydroseeding, all planting areas shall be weed free.

3.3 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. 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.

3.4 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread planting soil to a depth of 9 inches in turf areas and 18 inches at shrub bed areas but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
    a. Spread planting soil over loosened subgrade.
    b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Provide weed abatement procedure. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
    a. Apply soil amendments directly to surface soil before loosening.

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

G. Do not sow immediately following rain, or when ground is too dry. Temperature shall be between 55 F and 95 F for a 24 hour period. Wind shall be less than 5 mph.

H. Turf Seed shall be sown at a rate per seed supplier recommendations.

I. Seed shall be hydroseeded or drill seeded at the contractors option. Areas with a 4:1 or greater slope shall be hydroseeded.

3.5 DRILL SEEDING

A. Sow seed with cultipacker (“Brillion” equipment or equal), seeding machine, or approved similar equipment to drill, cover and firm the seed bed in one operation. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other. Apply water with a fine spray immediately after each area has been seeded. Saturate the top 4 inches of soil.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees.
3. Keep soil surface continuously damp.

B. Protect seeded areas with slopes exceeding 1:4 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application. Slopes in excess of 4 horizontal to 1 vertical shall b hydroseeded.

1. Mix slurry with nonasphaltic tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 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 subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, 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. Moisten prepared surface immediately prior to laying sod.

2. Lay sod immediately after delivery to site to prevent deterioration.
3. Lay sod across angle (perpendicular) of slopes exceeding 1:3.
4. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
5. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

C. Saturate sod with fine water spray immediately after 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.

3.8 TURF MAINTENANCE

A. 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. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. 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 1/3 of grass height. Remove no more than 1/3 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. Contractor shall be responsible to maintain, fertilize, and mow all phase one turf areas until 60 days after phase two final acceptance. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow specified turf areas to a height of 2 inches.

D. Turf Post fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Apply fertilizer in accordance with manufacturer's instructions.
2. Lightly water to aid the dissipation of fertilizer.
3. Sweep all hard surfaces of fertilizer overthrow.
4. Turf areas seeded months ahead of acceptance of the entire project will be fertilized on an eight to ten week schedule consistent with the seasonal period and application rates specified.

3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Landscape 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 98 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.
3. All turf areas will be accepted at the same time, including all phased areas.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with 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 Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 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. All scars, ruts or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. Contractor shall pick up all trash resulting from this work no less frequently than each Friday before leaving the site, once a week, and/or the last working day of each week. All trash shall be removed completely from the site. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition acceptable to the Owner and Construction Manager.

C. Erect temporary fencing or barricades and warning signs 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.

END OF SECTION 329200

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SECTION 329290 - TREE PROTECTION AND TRIMMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the protection and trimming of existing trees that interfere with, or are affected by, execution of the Work, whether temporary or permanent construction.

B. Related Sections include the following:
   1. Division 1 Section "Summary" for limits placed on Contractor's use of the site.
   2. Division 1 Section "Temporary Facilities and Controls" for temporary tree protection.
   3. Division 31 Section "Site Clearing" for removal limits of trees, shrubs, and other plantings affected by new construction.
   4. Division 31 Section "Earthwork" for building and utility trench excavation, backfilling, compacting and grading requirements, and soil materials.
   5. Division 32 Section "Trees, Plants, and Groundcovers" for tree and shrub planting, tree support systems, and soil materials.

1.3 DEFINITIONS

A. Tree Protection Zone: Area surrounding individual trees or groups of trees to remain during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 SUBMITTALS

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

B. Tree Pruning Schedule: Written schedule from arborist detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

C. Qualification Data: For tree service firm and arborist.

D. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

E. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

1.5 QUALITY ASSURANCE

A. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of tree protection and trimming.

B. Arborist Qualifications: An arborist certified by ISA or licensed in the jurisdiction where Project is located.

C. Tree Pruning Standard: Comply with ANSI A300 (Part 1), "Tree, Shrub, and Other Woody Plant Maintenance--Standard Practices (Pruning)."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Drainage Fill: Selected crushed stone, or crushed or uncrushed gravel, washed, ASTM D 448, Size 24, with 90 to 100 percent passing a 2-1/2-inch sieve and not more than 10 percent passing a 3/4-inch sieve.

B. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than **2 inches** in diameter; and free of weeds, roots, and toxic and other non-soil materials.
1. Obtain topsoil only from well-drained sites where topsoil is 4 inches deep or more; do not obtain from bogs or marshes.

C. Filter Fabric: Manufacturer's standard, nonwoven, pervious, geotextile fabric of polypropylene, nylon, or polyester fibers.

D. Temporary Fencing: ‘Tensar’ Citadel Safety Fence or Equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Temporary Fencing: Install temporary fencing around tree protection zones to protect remaining trees and vegetation from construction damage. Maintain temporary fence and remove when construction is complete.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

C. Do not store construction materials, debris, or excavated material inside tree protection zones. Do not permit vehicles or foot traffic within tree protection zones; prevent soil compaction over root systems.

D. Maintain tree protection zones free of weeds and trash.

E. Do not allow fires within tree protection zones.

3.2 EXCAVATION

A. Install shoring or other protective support systems to minimize sloping or benching of excavations.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots.
1. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If

encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction.

2. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

D. Where utility trenches are required within tree protection zones, tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.

1. Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments; do not break or chop.

3.3 REGRADING

A. Grade Lowering: Where new finish grade is indicated below existing grade around trees, slope grade beyond tree protection zones. Maintain existing grades within tree protection zones.

B. Grade Lowering: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist, unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed during grade lowering. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots with sharp pruning instruments; do not break or chop.

C. Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

3.4 TREE PRUNING

A. Prune trees to remain that are affected by temporary and permanent construction.

B. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.

C. Pruning Standards: Prune trees according to ANSI A300 (Part 1).

D. Cut branches with sharp pruning instruments; do not break or chop.

3.5 TREE REPAIR AND REPLACEMENT

A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to arborist's written instructions.

B. Remove and replace trees indicated to remain that die or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of 6-inch caliper size and of a species selected by Architect when damaged trees more than 6 inches in caliper size, measured 12 inches above grade, are required to be replaced. Plant and maintain new trees as specified in Division 2 Section "Exterior Plants."

3.6 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted.

B. Disposal: Remove excess excavated material and displaced trees from Owner's property.

END OF SECTION 329290

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SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.
4. Landscape edgings.

B. Related Sections:
1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
3. Division 32 Section "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 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 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. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. 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.

E. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

G. Finish Grade: Elevation of finished surface of planting soil.

H. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

I. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

J. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

K. Planting Area: Areas to be planted.

L. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

M. 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.

N. 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.

O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

P. 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.

Q. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

R. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

B. Samples for Verification: For each of the following:
   1. Certificates required by law that accompany shipments.

2. Bark Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
3. Compost Material: One gallon Ziploc bag with sample name, product material, including testing information.
4. Weed Control Barrier: 12 by 12 inches.
5. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
6. Root Barrier: Width of panel by 12 inches.

C. Qualification Data: For qualified 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.

D. 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.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

F. Warranty: Sample of special warranty.

G. Submit list of plant life sources, size and quality.
1. Substitutions: Submit list of plant life sources, size, quality and plants being recommended for substitution. Substitutions will not be approved unless non-availability can be demonstrated.

H. Project Record Documents:
1. Record plant locations, including substitutions, and quantities.

I. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

J. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for plant growth.

a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

K. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

L. 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.

M. 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 retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.

N. Preinstallation Conference: Conduct conference at project site.

O. Tree Pruning/Maintenance: ASNI A300 – American National Standard for Tree Care Operations – Tree, Shrub and Other Wood Plant Maintenance Standard Practices.

P. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.

1.5 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for compost material composition.

B. Comply with regulatory agencies for fertilizer and herbicide composition.

C. Plant Materials: Certified by federal department of agriculture; free of disease or hazardous insects.

1.6 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 conformance 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 fertilizers and soil amendments with appropriate certificates.

C. Deliver plants freshly dug.

D. Do not prune trees and shrubs before delivery, except as approved by Landscape Architect. 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.

E. Handle planting stock by root ball.

F. 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.

G. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

H. Deliver all plant material to the site in their original containers with labels intact and legible at the time of inspection.

I. Remove from the site all plants that are not true to name and all materials that do not comply with the provisions of this section.

1.7 PROJECT 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. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Architect's written permission.

C. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

D. 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.

E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise acceptable to Landscape Architect.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

2. Ensure proper irrigation coverage for plant watering.

1.8 WARRANTY

A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.

1. Warranty Period for Trees and Shrubs: One year from date of Substantial Completion.

2. Warranty Period for Ground Cover: Twelve (12) months from date of Substantial CompletionWhen warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

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 will be required except for losses or replacements due to failure to comply with requirements.
d. One (1) year warranty walk-through to review status of plants with Owner and Landscape Architect.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. 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: One month from date of Substantial Completion.

B. Initial Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. 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: One month from date of Substantial Completion.

C. Removal of tree stakes after one (1) year warranty walk-through is complete.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown 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 will be rejected.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

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 and shrubs with root balls measured from top of root ball, which shall begin 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 as shown on Drawings.

E. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.3 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. Product: Agriform 20-10-5, or approved equal.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.4 PLANTING SOIL MIX

A. Planting Soil Mix: Mix topsoil with the following soil amendments and fertilizers in the following quantities:
1. Ratio of Loose Compost to Topsoil by Volume: 1:5.

B. Additonal Amendments:
1. Fertilizer Tablets:
   a. Three (3) tablets for shrubs
   b. Eight (8) tablets for trees.

2.5 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Wood and bark chips.
2. Size Range: 3 inches maximum, 2 inch minimum.
3. Color: Natural.

2.6 WEED-CONTROL BARRIERS

A. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd..

2.7 PESTICIDES

A. General: Pesticide registered and approved by 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 Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

2.8 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or 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. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
3. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by plant stem; sized as indicated and per manufacturer's written recommendations.

    a. Products: Subject to compliance with requirements, provide the following or approved equal:

        1) Arborbrace; ArborBrace Tree Guying System.

        2) Arbortie by Deeproot, www.deeproot.com .

2.9 MISCELLANEOUS PRODUCTS

A. 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.

B. Planter Filter Fabric: Woven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

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. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling 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 and which is too 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.

3.2 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 Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

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.

3.3 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 4 inches. Remove stones larger than 1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

2. Spread planting soil to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. 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.

1. Excavate approximately three times as wide as ball diameter for stock.
2. Excavate at least equal width of rootball.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
4. 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.
5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected after working hours or when unattended by Installer's personnel.

B. Subsoil and topsoil removed from excavations may be used as planting soil.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Landscape 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.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Before 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. **Remove <u>all</u> burlap and wire baskets from root balls. Remove all nails, ties, and plastic from the trunk and root ball.** Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

C. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

D. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting 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 in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Set container-grown stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting soil for backfill.
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 in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole. Place mycorrhizal fungal transplant inoculant in doughnut shape around rootball.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. 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.

3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices, see ASNI-A300, Paragraph 5.4.1 Young Tree Pruning at Planting. Unless otherwise indicated by Landscape Architect, **do not cut tree leaders**; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

A. Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: 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 to the dimension shown on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Use two stakes for trees up to 12 feet high and 3 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.
3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
4. 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.

3.8 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 will minimally disturb 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.

3.9 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 6 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
2. Organic Mulch 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.

3.10 EDGING INSTALLATION

A. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- deep, shovel-cut edge as shown on Drawings.

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. Spray or treat as required to keep trees and shrubs free of insects and disease.

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 past management practices whenever possible to minimize the 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 in accordance with 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 Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. 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.

C. 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.

3.14 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

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