

**SECTION 000101.3
PROJECT TITLE PAGE - VOL III**

PROJECT MANUAL

FOR

**CHICO AQUATIC AND RECREATIONAL FACILITY
PROJECT NUMBER 23030 CH**

**100% PERMIT REVIEW AND BID
1/24/25**

**VOLUME III OF III
DIV 22-33 | (PAGE 526 OF 948)**

PREPARED BY:

**CONFLUENCE
WWW.THINKCONFLUENCE.COM**

220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 DESCRIPTION OF SYSTEMS

- A. Division 22 includes but is not limited to:
 - 1. Section 22 0500 – Common Work Results for Plumbing.
 - 2. Section 22 0553 – Plumbing Identification.
 - 3. Section 22 0700 – Plumbing Insulation.
 - 4. Section 22 1000 – Pipe, Valves and Pipe Specialties.
 - 5. Section 22 2000 – Plumbing Systems.

1.02 DESCRIPTION OF WORK

- A. Work Included: Unless specified otherwise, provide all supervision, labor, materials, transportation, equipment, hauling, and services necessary for a complete and operational mechanical system. Provide all incidental items such as offsets, fittings, etc. required as part of the work even though not specifically shown on Contract Drawings or Specifications.
- B. Requests for Information: See Section 01 2000 – Price & Payment Procedures, for required research of Contract Documents and subsequent documentation of noted issues through requests for information.
- C. Existing Utilities are indicated as accurately as possible on the Drawings. If utilities are encountered and not indicated on Drawings, notify the Architect prior to proceeding with work.
- D. Types of mechanical related work specified in this section include the following:
 - 1. Access Doors.
 - 2. Excavation.
 - 3. Cutting and Patching.

1.03 SUBMITTALS

- A. Provide the following submittals:
 - 1. Access Doors.

1.04 UTILITIES, EXTENSIONS, CONNECTIONS AND FEES FOR WATER, SEWER AND GAS

- A. Provide all services within the building to a point five (5) feet outside of building. Provide permanent marker at grade for other contractors' location reference for connection purposes.
- B. In the event that the serving utility (gas) company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Owner. Extensions from termination points to connection with building services and systems will be the responsibility of the Division 22 Contractor.
- C. In the event that the water service to the building is a combination domestic and fire protection service, the responsibility of said "combination service" to the point of domestic connection shall

be that of a licensed Fire Protection Contractor, including tap, valves, excavation, backfill, compaction and meters, if any. After point of domestic connection, responsibility for separate fire and domestic services is with appropriate trades including all labor and materials as herein before mentioned.

1.05 REFERENCES

- A. For products or workmanship specified by Association, Trade or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. The date of the standard is that which is in effect as of the date of the Contract Documents, except when a specific date is specified.

1.06 QUALITY CONTROL

- A. See Division 01 for general quality control requirements.
- B. Materials and apparatus required for the plumbing scope of work shall be new and of first-class quality. Delivered, erected, connected and finished in every detail, and selected and arranged so as to fit properly into the building spaces.
- C. Unless otherwise specifically indicated, equipment and materials shall be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

1.07 EXAMINATION OF CONTRACT DRAWINGS AND SPECIFICATIONS

- A. The Plumbing Drawings show the general arrangement of piping, plumbing equipment, and appurtenances, and shall be followed as closely as actual building construction and the work of other trades will permit.
- B. The Architectural and Structural Drawings shall be considered part of the plumbing work insofar as these Drawings furnish this Division with information relating to design and construction of the building.
- C. Field verify building dimensions governing plumbing work. Do not scale the Plumbing Drawings for dimensions.
- D. The Plumbing Contractor shall request of the Test and Balance (TAB) Contractor an early review of the Contract Documents for the purpose of identifying where proper balancing cannot be achieved. The report requirements are specified in Division 23, Temperature Controls section, "Submittals." Forward a copy of the report to the Mechanical Engineer for review. The Plumbing Contractor shall modify the system as recommended by the TAB Contractor or refer unresolved issues to the Mechanical Engineer for resolution prior to ordering of equipment. Unresolved balancing issues from untimely or incomplete application of these requirements will be the responsibility of the Plumbing Contractor to correct.
- E. Discrepancies:
 - 1. Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the drawings for the work of this Division and the drawings for the work of

others, report such discrepancies as a request for information following the procedure outlined in Division 01.

2. Should there be a conflict in dimensions or locations between Plumbing Drawings and/or other Drawings, report such discrepancies as a request for information following the procedure outlined in Division 01.

1.08 REGULATORY REQUIREMENTS

- A. See Division 01 for applicable codes and regulations.

1.09 COORDINATION

- A. See Division 01 for coordination requirements and procedures between all applicable construction trades.
- B. Before purchase, fabrication, or installation of plumbing components, determine if the installation will properly fit and can be installed as contemplated without interference with structural elements or the work of other trades.
- C. Locations of pipes, ducts, switches, panels, equipment, and fixtures, shall be adjusted to accommodate the work or interferences anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.
- D. Right of Way: Lines which pitch shall have the right-of-way over those which do not pitch. Lines whose elevations cannot be changed shall have right-of-way over lines whose elevations can be changed.
- E. Offsets, transitions and changes in direction of pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the Drawings.
- F. Where major conflicts occur, contractor shall rely upon the Architect/Engineer to make final decision regarding priority of right-of-way. Prior to installation or removal of components in conflict, report any such conflicts as a request for information following the procedure outlined in Section 01 2000.
- G. When directed by the Architect/Engineer, submit Coordination Drawings showing interrelationship of various portions of work and work of other trades. Failure to properly coordinate may result in removal and relocation at expense to the Contractor.
- H. Coordination Drawings for Acoustical and Drywall Ceilings, Plumbing, Fire Protection, HVAC and Electrical shall be provided in accordance with requirements listed in Division 01.
- I. Coordinate all cutting & patching, provide per Division 01.
- J. Utility Interruptions: Coordinate mechanical utility interruptions with the general contractor per Division 01.

1.10 COMMISSIONING

- A. Division 22 is responsible to participate in the commissioning process. See Division 01. The commissioning process and contractor responsibilities are described in these sections.

Plumbing contractor, sub-contractors and manufacturers equipment start-ups to comply with these sections and provide coordination with the commissioning agent as required.

1.11 PROJECT CONDITIONS

A. Accessibility:

1. Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of work. Such spaces and clearances shall be kept to the minimum size required.
2. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect prior to making the change.
3. Determine the exact locations of access doors. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.
4. Demonstration of access will be required prior to project completion. The contractor is responsible for providing reasonable and safe access for all system components. Plumbing Contractor to demonstrate access and serviceability of all equipment to Owner.

B. Fabrication: Before installing and/or fabricating any lines of piping or ductwork the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

C. Freeze Protection: Do not run pipes in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

D. Scaffolding, Rigging and Hoisting: Provide scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.12 SUBMITTALS

A. See Division 01 for submittal procedures applicable to all sections in Division 22.

B. The review comments of the Architect and/or Engineer do not in any case supersede the Drawings and Specifications, and shall not relieve the Contractor from responsibility for deviations from the Drawings or Specifications unless the Contractor has called to the attention of the Architect and/or Engineer, in writing, such deviations at the time of submission, nor shall it relieve the Contractor from responsibility for errors of any sort in the items submitted.

C. Deviations: It is the contractor's responsibility to indicate deviations from the Plans and Specifications. Approval shall not be considered acceptance of the deviation unless it has been explicitly indicated.

1.13 SEISMIC RESTRAINT PLAN SUBMITTAL:

A. The Plumbing Contractor shall provide a vibration and seismic restraint plan for projects designated a Seismic Design Category C (with a seismic importance factor greater than 1.0), D, E, or F as found on the structural drawings. The plan shall include stamped and signed

(engineer with minimum of 5 years of experience) drawings for the state in which the project is located, details, equipment cutsheets, and analysis from one of the acceptable equipment manufacturers listed below for the entire project scope. The Plumbing Contractor will provide the selected equipment manufacturer with a copy of the drawings, specifications, soil reports and any other pertinent information necessary to perform the vibration and seismic restraint analysis per pertinent codes.

B. Acceptable Manufacturers:

1. Mason Industries, Inc.
2. Kinetics Noise Control, Inc.
3. M. W. Sausse & Co., Inc.
4. Amber/ Booth, a VMC Company
5. Vibro Acoustics

1.14 FIELD REPORTS

- A. During the construction period the Engineer may issue periodic field reports. The contractor shall immediately address the issues and provide a written response.
- B. The written response must be returned to the Architect no later than (5) working days after receipt of the site observation report.

1.15 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Substitutions: See Division 01 for substitution procedures applicable to all products specified in Division 22.
- B. When alternate or substitute materials and equipment are used, Contractor will be responsible for space requirement, configurations, performance, changes in bases, supports, structural members and opening in structure, electrical changes and other apparatus and trades that may be affected by their use. Contractor shall provide drawings for alternate/substitute equipment in detail equal to the Construction Documents.

1.16 PROJECT RECORD DOCUMENTS

- A. See Division 01 for submittal requirements and procedures.

1.17 ELECTRIC WIRING AND SAFETY DEVICE WORK AND MATERIAL RESPONSIBILITIES

- A. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired in accordance with the following schedule: PD = Plumbing Division, MD = Mechanical Divisions, ED = Electrical Division, FD = Fire Protection Division, TD = Temperature Control Division, I = Installer of equipment requiring electrical service.
- B. Note: If Temperature Control Division is a subcontract to the HVAC Contractor, both MD and TD shall fall under the responsibility of MD. If no Temperature Control Contractor is under contract, Mechanical Division shall assume all Temperature Control responsibilities.

	Furnished Under	Set in Place or Mounted Under	Power Wired & Connected Under	Control Wired & Connected Under
1. Mechanical Magnetic Motor Starters, VFD's	PD	PD	ED	TD
2. Control Wiring Regardless of Voltage	TD	TD	TD See footnote 1	TD
3. Control Components: Control Relays, Control Transformers, EP, PE Switches	TD	TD	TD See footnote 1	TD
4. Control Valves, Solenoid Valves, Plumbing Fixtures	TD	PD	--	TD
5. Thermowells in Piping	TD	PD	--	--
6. Fused and Unfused Disconnect Switches & Thermal Overload Switches	ED See footnote 2	ED See footnote 2	ED	--
7. Contactors	ED	ED	ED	ED
8. Water Heater Controls	PD	PD	TD See footnote 1	TD

1. Footnote 1: It is the intention of this specification for all conduit and wiring which connects to control equipment or provides controls to mechanical equipment to be provided by the Temperature Control Contractor. Other portions of the specification which may be in conflict with this concept shall be brought to the attention of the engineer for clarification prior to bidding the project. The ED shall provide line voltage wiring conduit and junction boxes for the express purpose of temperature controls. It shall be the responsibility of the Temperature Control Contractor to coordinate the location of the junction boxes (if not otherwise shown on the Electrical Drawings) and to utilize these junction boxes for temperature control wiring. The Temperature Control Contractor shall extend line and/or low voltage wiring from junction boxes to all mechanical and control components which require control wiring.
2. Footnote 2: Unless furnished with equipment.

- C. Provide Division 26 with a complete summary list of all plumbing equipment control requiring electric power within 30 days after award of contract. This list shall summarize equipment power loads, line voltage control requirements, quantities, and locations of equipment and connection points. If any plumbing equipment is required to run on emergency power, the list shall note that requirement along with the requirement for the building temperature controls systems to also be under emergency power.

1.18 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements specified in Division 01.

1.19 WARRANTIES

- A. See Division 01 for general warranty requirements.

1.20 SCHEDULE OF TESTING

- A. See Division 01 for testing requirements and procedures.

- B. Make all specified tests on piping and related systems as necessary. Demonstrate the proper operation of equipment installed under this project.
- C. Equipment shall not be tested, or operated for any purpose until fully lubricated in accordance with manufacturer's instructions and until connections to fully operative systems have been accomplished.
- D. A schedule of testing shall be prepared in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel. All testing must be performed in the presence of the General Contractor's representative; his signature for verification of the test must appear on the schedule. At completion of testing, the schedule shall then be submitted in triplicate to the Architect.
- E. Make sure operational and performance tests are made on seasonal equipment (equipment not operating year-round).

1.21 DEMONSTRATION OF ACCESS

- A. The Contractor shall demonstrate to the Owner's designated representative the access to all switches, valves, actuators, dampers, motors, lubrication lines, sensors and panels. Contractor shall correct deficiencies noted by the Owner. Refer outstanding issues to the Architect/Engineer for resolution. Contractor to be responsible for arranging the demonstration prior to final inspection.

1.22 KEYS

- A. Keys: Upon completion of work, submit keys for plumbing equipment, panels, etc. to the General Contractor.

1.23 OPERATING AND MAINTENANCE DATA

- A. See Division 01 for Operating and Maintenance Manual requirements.

1.24 INSTRUCTIONAL SESSIONS

- A. See Division 01 for all instruction session requirements. Provide separate training on respective systems per this section.

PART 2 PRODUCTS

2.01 ACCESS DOORS

- A. See Division 01.
- B. Furnish access doors where shown on Drawings and at all locations where required for access to concealed valves, shock absorbers, dampers, cleanouts, control devices, coils, and equipment servicing. Access doors shall be 12" x 12" for hand access and 24" x 24" for head and shoulder access, or as indicated.

PART 3 EXECUTION

3.01 ACCESS TO PLUMBING WORK

A. Installation:

1. Provide access doors for installation and provide instructions for their location. Exact location of access doors to be as directed by Mechanical Contractor and Architect/Engineer.
2. Furnish all access doors whether shown or not.
3. Comply with manufacturer's instructions for installation of access doors.
4. Coordinate installation with work of other trades.
5. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.
6. Access door location shall be coordinated with Architect/Engineer prior to installation. All access panels not coordinated will run the risk of removal and relocation at the expense of the contractor.
7. Install access doors for the following concealed equipment:
 - a. Shock absorbers.
 - b. Valves.
 - c. Control devices.
 - d. Trap primers.
 - e. Other plumbing equipment requiring service.

B. Adjust and Clean:

1. Adjust hardware and panels after installation for proper operation.
2. Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

3.02 EXCAVATING FOR MECHANICAL WORK

A. Refer to Division 01.

B. General: Do not excavate for mechanical work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.

C. Existing Utilities: Locate and protect existing utilities and other underground work in manner which will ensure that no damage or service interruption will result from excavating and backfilling.

D. All trenches deeper than the footing of any building or structure and paralleling the same shall be at least forty-five (45) degrees therefrom, unless permission is otherwise granted by the Administrative Authority and Structural Engineer.

E. Excavation for Trenches: Dig trenches to uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of piping:

1. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups.

2. Where rock is encountered, carry excavation 6" below required elevation and backfill with 6" layer of 3/4" gravel prior to installation of pipe.
 3. Where bedding is required, backfill with sand 6" below and 6" above pipe.
 4. For piping 5" or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support piping on undisturbed soil.
 5. For piping 6" and larger in nominal size, tanks, and other mechanical work indicated to receive sub-base, excavate to sub-base depth indicated, or if not otherwise indicated, to 6" below bottom of work to be supported.
 6. Grade bottoms of trenches as indicated, notching under piping couplings to provide solid bearing for entire body of piping.
- F. Shape sub-bases and bottoms of excavations with recesses to receive pipe bells, flanged connections, valves and similar enlargements in piping systems.
- G. Concrete Encasement: Where piping under roadways is less than 2'-6" below surface of roadway, provide 4" base slab of concrete to support piping. After piping is installed and tested, provide 4" thick encasement (sides and top) of concrete before backfilling. Provide Class 2500 concrete for encasement and slab.

3.03 BACKFILLING

- A. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.
- B. All excavations shall be completely backfilled as soon after inspection as practical. Adequate precaution shall be taken to ensure proper compactness (95% density) of backfill around piping without damage to such piping. Trenches shall be backfilled in thin layers to twelve (12) inches (0.3m) above the top of the piping with clean earth which shall not contain stones, boulders, cinderfill, or other materials which would damage or break the piping or cause corrosive action. Mechanical devices such as bulldozers, graders, etc., may then be used to complete backfill to grade. Fill shall be properly compacted (95% density). Suitable precautions shall be taken to ensure permanent stability for pipe laid in filled or made ground.

3.04 EXISTING PIPES AND PLUMBING EQUIPMENT TO BE REMOVED

- A. Where existing plumbing equipment, fixtures and/or piping is to be removed and/or relocated, all piping shall be disconnected and capped. All existing piping and hangers not to remain in use shall be removed completely to an existing main that is to remain in use, and capped at the main. All existing equipment not to remain in use shall be removed completely. General Contractor shall do all cutting, patching, and restoring that may be required for the removal of this piping and equipment. Where it is not possible to remove branch piping not remaining in use due to its being concealed in the structure, the Division 22 Contractor shall cap the concealed piping at both ends in these areas as approved by the Architect.
- B. All mechanical equipment, fixtures, and piping to be removed and not re-used shall remain the property of the Division 22 Contractor and used as credit to the contract price except as noted otherwise.

3.05 CUTTING AND PATCHING

- A. See Division 01 for Cutting & Patching Procedures.

END SECTION

220553

PLUMBING IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Types of identification devices specified in this section include the following:
1. Plastic Pipe Markers.
 2. Plastic Tape.
 3. Valve Tags.
 4. Valve Schedule Frames.
 5. Engraved Plastic-Laminate Signs.
 6. Plastic Tags.

1.02 SUBMITTALS

- A. Provide the following submittals:
1. Pipe Marker.
 2. Valve Tags.
 3. Engraved Signs.
 4. Equipment Tags.

1.03 REFERENCES

- A. American National Standards Institute (ANSI)
1. ANSI A13.1 "Scheme for Identification of Piping Systems".
 2. ANSI Z53.1 "Safety Color Code for Marking Physical Hazards".
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

PART 2 PRODUCTS

2.01 IDENTIFICATION MATERIALS

- A. General: Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.02 PLASTIC PIPE MARKERS

- A. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- B. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.

- C. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Adhesive lap joint in pipe marker overlap.
 - 2. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 3. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

- D. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - 1. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide, full circle at both ends of pipe marker, tape lapped 3".
 - 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless-steel bands.

- E. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with name as shown or specified.

2.03 PLASTIC TAPE

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

- B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6". Provide 2 1/2" wide tape for larger pipes.

- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.04 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fastener.
 - 1. Provide 1-1/2" diameter tags.

- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain **wire link or beaded type**, or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

- C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.05 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.06 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, **black / red** with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Fasteners: Self-tapping stainless-steel screws, except contact- type permanent adhesive where screws cannot or should not penetrate the substrate.

2.07 PLASTIC TAGS

- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow.
 - 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.03 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
- B. Mount valve schedule frames and schedules in boiler rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

3.04 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 2. Meters, gauges, thermometers and similar units.
 3. Fuel-burning units including water heater.
 4. Pumps and similar motor-driven units.
 5. Tanks and pressure vessels.
 6. Strainers, filters, and similar equipment.
- B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Lettering Size: Minimum 1" high lettering for name of unit.
- D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions and warn of hazards and improper operations.

END SECTION

220700
PLUMBING INSULATION

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Types of plumbing insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Glass Wool / Fiberglass.
 - b. Flexible Elastomeric.

1.02 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials UL/ULC Classified per UL 723 or meeting ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. Provide the following submittals:
 - 1. Pipe Insulation.
 - 2. Pipe fitting insulation.
 - 3. Adhesives.
 - 4. Sealants.
 - 5. Mastics.
 - 6. Field Applied Jackets.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. General:

1. Products shall not contain asbestos, lead, mercury, or mercury compounds if possible. Products shall be Certified UL GREENGUARD Gold or Indoor Advantage Gold, if possible.
2. Insulation materials applied to carbon steel shall be Mass Load Corrosion Rate (MLCR) tested per ASTM 1617.
3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
5. All insulation materials installed within a plenum shall meet a flame spread rating of 25 and a smoke developed rating of 50 when tested per ASTM E84.
6. Factory Applied Jacketing:
 - a. FSK – Foil Scrim Kraft. Aluminum foil, fiberglass reinforced scrim, kraft paper backing. **Silver finish.**
 - b. FSP – Foil Scrim Polyethylene. Aluminum foil, fiberglass reinforced scrim, polyethylene backing. **Silver finish.**
 - c. ASJ – All Service Jacket. Kraft paper, fiberglass-reinforced scrim, with aluminum backing. **Paper-white finish.**
 - d. ASJ-SSL – ASJ with Self Seal Lap. Self-sealing, pressure-sensitive, acrylic based adhesive covered by removable protective strip. **No staple, faster install, for piping.**
 - e. PSK – Polypropylene Scrim Kraft or “poly-top” jacketing, **white finish**, greater puncture resistance, no water stains, cleanable vs. ASJ/FSK.
 - f. Vinyl – Similar look to PSK, older project, high permeability. Not used.

B. Piping Insulation:

1. Flexible Elastomeric Insulation (PEX-A only):
 - a. Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1) Factory Applied Jacket:
 - a) None.
 - 2) Field Applied Jacket:
 - a) See requirements below. (Aluminum Jacketing).
 - b. Acceptable Manufacturers:
 - 1) Aeroflex: Aerocell.
 - 2) Armacell: Armaflex AP.
 - 3) K-Flex: Insultube.
2. Glass Wool / Fiberglass, Preformed Pipe Insulation:
 - a. Type I, 850° F min. Materials: Glass Wool / Fiberglass bonded with a thermosetting resin. Comply with ASTM C 585, ASTM C 411, ASTM C795, and ASTM C 547, Type I and Type IV, with factory-applied ASJ.
 - 1) Factory Applied Jacket:

- a) ASJ-SSL – comply with ASTM C 1136, Type 1.
- 2) Field Applied Jacket:
 - a) See requirements below.
- 3) Acceptable Manufacturers:
 - a) Johns Manville: Micro-Lok HP
 - b) Knauf Insulation: Earthwool 1000°
 - c) Owens Corning: Fiberglass Pipe Insulation

2.02 ADHESIVES

A. General:

- 1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Calcium Silicate Adhesive:

- 1. Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

C. Flexible Elastomeric and Polyolefin Adhesive:

- 1. Comply with MIL-A-24179A, Type II, Class I.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive:

- 1. Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive:

- 1. Compatible with PVC jacket.

2.03 MASTICS

A. General:

- 1. Materials shall be compatible with insulation materials, jackets, and substrates.
- 2. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic:

- 1. Water based; suitable for indoor use on below-ambient services.
- 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.04 at 40-mil dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 52 percent by volume and 62 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic:

1. Solvent based; suitable for outdoor use on below-ambient services.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

2.04 SEALANTS

A. General

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Joint Sealants for Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

C. ASJ Flashing Sealants, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.05 FIELD-APPLIED JACKETS

A. General:

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

B. FSK Jacket:

1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket:

1. High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 30 mils or less thickness; roll stock ready for shop or field cutting and forming.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
4. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps and mechanical joints
5. Acceptable Manufacturers:

- a. Johns Manville.
- b. Knauf.
- c. P.I.C. Plastics, Inc.
- d. Proto Corporation.
- e. Speedline Corporation.

D. Metal Jacket:

- 1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. 0.016" thick smooth or embossed finish.
 - c. Moisture Barrier for Indoor Applications: 1-mil - thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 2.5-mil - thick polysurlyn.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- 2. Acceptable Manufacturers:
 - a. Ideal Products.
 - b. ITW Insulation Systems.
 - c. RPR Products, Inc.
 - d. Pittsburgh Corning Corporation.
 - e. Polyguard Products, Inc.

E. Self-Adhesive Aluminum Outdoor Jacket:

- 1. 60-mil - thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
- 2. Acceptable Manufacturers:
 - a. Polyguard Products, Inc.
 - b. Venture Tape.

PART 3 EXECUTION

3.01 GENERAL

- A. Inspection: Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

- B. Insulation Thickness: Pipe insulation thickness shall be in accordance with the minimum thicknesses listed in the latest edition of the International Energy Conservation Codes and ASHRAE 90.1.
- C. R Values: Insulation R values shall be in accordance with the latest edition of the International Energy Conservation Codes.

3.02 PLUMBING PIPING SYSTEM INSULATION

- A. General: Insulate plumbing piping per the following table.

PLUMBING PIPING INSULATION SCHEDULE					
System	Location	Type	Pipe Size	Thickness	Jacket
40°F-60°F <ul style="list-style-type: none"> • Domestic Cold-Water Piping • Air Conditioner Condensate Drain Piping 	Interior	Glass Wool / Fiberglass	All	1"	Factory ASJ-SSL Vapor Barrier
	Exterior/ Below Grade	Flexible Elastomeric	All	1-1/2"	None
<ul style="list-style-type: none"> • Roof/Overflow Drain Body, Horizontal Piping and 1st Vertical Portion 	Interior	Glass Wool / Fiberglass	All	1"	Factory ASJ-SSL Vapor Barrier
105°F-140°F <ul style="list-style-type: none"> • Domestic Hot Water • Domestic Hot Water Recirculation Piping 	Interior	Glass Wool / Fiberglass	≤ 1-1/4"	1"	Factory ASJ-SSL
	Exterior/ Below Grade		Flexible Elastomeric	All	
Pipe Fitting Covers	Interior	PVC Covers	All	System Match	Factory PVC
Notes: <ul style="list-style-type: none"> • Interior location is inside of building thermal envelope. • Exterior location is outside of building thermal envelope (i.e. rooftop or grade mounted piping). 					

- B. Omit insulation on chrome-plated exposed piping (except for ADA fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.
- C. Provide insulation within building partition wall.
- D. Encase pipe fitting insulation with flame and smoke rated one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.

3.03 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on insulation, and protect to prevent puncture or other damage.
- F. Insulation Installation on Valves and Pipe Specialties: Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Apply insulation as follows:
 - 1. Install preformed section of same material as straight segments of pipe insulation when available.
 - 2. When pre-formed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.
- G. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- H. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation.
 - 2. Install with preformed pipe fitting covers as scheduled.
 - a. Overlap at longitudinal seams and end joints for horizontal applications.
 - b. Seal with manufacturer's adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- I. Extend insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- J. Insulation should go through the hanger with the insert carefully placed in a notch in the insulation at the 6 o'clock position between the pipe and the shield. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.
- K. Install insulation and vapor barrier jackets continuous over piping at trapeze hangers.

3.04 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Replace and repair insulation disturbed by testing and balancing procedures required under Section 23 0593 – Testing, Adjusting and Balancing.

- C. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END SECTION

221000

PIPE, VALVES & PIPE SPECIALTIES

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Types of equipment specified in this section include the following:
1. Pipes and Pipe Fittings.
 2. Valves.
 3. Pipes Specialties.
 4. Expansion Devices.
 5. Supports and Anchors.
 6. Meters and Gauges.

1.02 SUBMITTALS

- A. Provide the following submittals:
1. Pipe and Fittings.
 2. Grooved joint couplings.
 3. Soldering and Brazing Material.
 4. Valves.
 5. Backflow Preventers.
 6. Escutcheons.
 7. Strainers.
 8. Dielectric Fittings.
 9. Fire Barrier Sealants.
 10. Water Hammer Arrestors.
 11. Sleeve Seals.
 12. Hangers and Supports.
 13. Shields.
 14. Thermometers.
 15. Pressure Gauges.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.
 2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

- A. Shall be of material, weight, ASTM and ANSI Designation, and pressure ratings as follows unless specifically accepted otherwise.

- B. Above Ground Storm Drain, Waste, and Vent Piping:
 - 1. Pipe Size 10" and Smaller: Hubless cast-iron soil pipe fittings conforming to CISPI 301. Acceptable manufacturers: AB&I, Charlotte Pipe, Tyler Pipe and NewAge Casting.
 - a. Hubless Joints:
 - 1) Standard couplings equal to CISPI 310.
 - a) All vent piping
 - 2) Heavy-Duty Couplings with 304 stainless steel band, bolts, etc. equal to Husky HD2000, Clamp-All 80, Mission HD, Ideal HD on the following piping:
 - a) All waste piping
 - 3) Extra Heavy-Duty Coupling with all stainless-steel band, bolts, etc. equal to Husky SD4000.
 - a) All roof drain, overflow drain and storm drain piping.
 - 2. Pipe size 1 1/2" and Smaller: DWV copper with DWV pattern solder joints.
- C. Underground Storm Drain and Building Drain Piping to 5 Feet Beyond Building Line:
 - 1. Pipe size 8" and smaller: Schedule 40 PVC solid core (only), PVC-DWV pipe with DWV drainage fitting and solvent welded joints. ASTM D-2665, ASTM D-2321 (underground installation) and ASME B31.3 (Bunder's Qualification).
- D. Domestic Water Service Outside of Building:
 - 1. 3" and Smaller: Type "K" hard drawn copper, all joints to be brazed.
- E. Domestic Cold, Hot, Hot Water Recirculation Piping Underground:
 - 1. 2" and Smaller:
 - a. Pipe: PEX piping equal to Uponor "AquaPEX" (PEX-A), high density polyethylene, cross linked. Must meet the following standards: ASTM F876, ASTM F877, ASTM F1807, ASTM, 1960, ASTM F2080, ANSI/NSF Standard 14 and 61.
 - b. Fittings: polyethylene fittings only.
- F. Domestic Cold Water, Hot Water, Hot Water Recirculation and Condensate Piping Above Ground Inside Building:
 - 1. 4" and Under:
 - a. Pipe: Type L, hard drawn, seamless copper tubing ASTM B 88-70.
 - b. Fittings: Wrought copper solder joint pressure type fittings as per ANSI B16.22 or cast copper solder joint fittings as per ANSI B16.18.
 - c. Joints: Canfield 100% watersafe solder for pipe sizes 1 1/2" and smaller, and brazed joints 2" and larger. Antimony is not allowed in solder.
 - 2. 4" and Under
 - a. Press Fittings: Copper press fittings shall conform to the material and sizing requirements of ASME B16.54.

- b. For Types K and L hard copper tubing 1/2" to 4" and soft copper tubing in 1/2" to 1-1/4".
- c. Housing: Copper or bronze.
- d. Sealing Element: EPDM.
- e. Multiple leak path detection system.
- f. IAPMO PS-117.
- g. Tools: Manufacturer's special tools.
- h. Maximum 300 psig (2069 kPa) working-pressure.
- i. Maximum temperature rating at 250 deg F (121 deg C).
- j. Maximum test pressures at 600 psig (4136 kPa).
- k. Fittings for 2" and Smaller: Wrought-copper fitting with EPDM-rubber, sealing element in each end.
- l. Fittings for 2-1/2" to 4": Cast-bronze or wrought-copper with stainless-steel grip ring and EPDM-rubber, sealing element in each end.
- m. Manufacturers for copper press fittings:
 - 1) Viega, 17545 Daleview Dr., Lakewood, OK 44107, 877-620-0016
 - 2) Nibco, Inc.
 - 3) Apollo
 - 4) Or Approved Equal

G. Natural Gas and Natural Gas Relief Vent Piping, Above Ground Inside Building and Above Ground Exterior:

- 1. Pipe: Schedule 80 ASTM A-53, Grade B, Type E or ASTM A-53 Grade A, Type F for pipe sizes 1/2" and under; Schedule 40 ASTM A-53, Grade B, Type E or ASTM A-53 Grade A, Type F for pipe sizes over 1/2". Piping must be UL listed and FM approved.
- 2. Threaded/welded fittings:
 - a. 1/2" and Under: 300-pound malleable iron (ASTM B16.2) flat banded pattern screwed fittings per ANSI B16.3.
 - b. Over 1/2" thru 2": Same as above except 150-pound class, screwed or welding fittings per joints below.
 - c. Over 2": Schedule 40, seamless carbon steel welding fittings, long radius, 150-pound class, dimensions per ANSI B16.9-1971; ASTM A 234-73, Grade WPB.
- 3. Press fittings:
 - a. Over 1/2" thru 2": Carbon steel press connect fittings.
 - b. Fittings shall conform to CSA/IAPMO LC-4 and ICC-ES PMG1036.
 - c. Fittings shall be equal to ASTM A-106 Grade A Carbon Steel with Zinc-nickel coating and designed for use with IPS SCH 10 thru SCH 40 carbon steel or galvanized pipe conforming to ASTM A53, ASTM A106, ASTM A135, or ASTM A795.
 - d. Fittings shall have an HNBR sealing element, 420 stainless steel grip ring, 304 stainless steel separator ring, and Yellow color coded Press Indicator rings.
 - e. Approved manufacturers:
 - 1) Apollo Valves; PowerPress
 - 2) Nibco; BenchPressG
 - 3) Viega
- 4. Joints:
 - a. 2" and Under: Threaded using joint compound resistant to gas-air mixture.
 - b. 2" and Under: Carbon steel press connect.

- c. 2-1/2" and Above: Butt-welded.
- d. Note: Weldolets, Threadolets, Sockolets, where permitted by authorities having jurisdiction may be used in lieu of standard fittings on natural gas piping.

H. Sump Pump and Sewer Ejector Discharge:

- 1. Pipe: Schedule 40 solid core PVC if not located in a return air plenum.
- 2. Fittings: solvent welded DWV Schedule 40 solid core PVC joints.

2.02 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.

- 1. Comply with AWS D10.12M/D1.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- 2. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.

- 1. Canfield 100% Water Safe. "No Antimony."

C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.

- 1. AWS A5.8/5.8M BCuP Series, copper-phosphorus alloys for joining copper with copper.
- 2. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.

D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

E. Solvent Cements for Plastic Piping:

- 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

F. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

- 1. Acceptable Manufacturers:
 - a. Fernco, Inc.
 - b. Indiana Seal

2.03 VALVES

A. General: Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be manufactured in accordance with all

applicable M.S.S. Standards. All valves intended to supply drinking water shall meet NSF-61 (180° F C. Hot). All valves installed in the plumbing system shall be lead free in accordance with NSF-372.

- B. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
- C. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, 6" and smaller, other than plug valves. Provide one wrench for every 10 plug valves. **Provide gear operators for quarter-turn valves 8" and larger. Provide chain-operated sheaves and chains for overhead valves as indicated.**
- D. Acceptable Manufacturer's
 - 1. Drain Valves:
 - a. Apollo.
 - b. Hammond/Milwaukee Valve Corp.
 - c. Nibco, Inc.
 - 2. Gas Plug Valves:
 - a. DeZurik Co.
 - b. Homestead.
 - c. Nordstrom.
 - d. Power.
 - e. Walworth Co.
 - 3. Gas Cocks:
 - a. Conbraco/Apollo.
 - b. DeZurik Corp.
 - c. Nibco, Inc.
 - 4. Ball Valves:
 - a. Apollo.
 - b. Hammond/Milwaukee Valve Corp.
 - c. Nibco, Inc.
 - d. Watts Co.
 - 5. Butterfly Valves:
 - a. Apollo.
 - b. Centerline.
 - c. DeZurik Co.
 - d. Keystone.
 - e. Nibco, Inc.
 - 6. Swing Check Valves:
 - a. Apollo.
 - b. Hammond/Milwaukee Valve Corp.
 - c. Nibco, Inc.
 - d. Watts.

7. Wafer Check Valves:
 - a. Apollo.
 - b. Centerline.
 - c. Crane/Jenkins/Stockham.
 - d. Nibco, Inc.
 - e. Mission.
 - f. Titan FCI.

8. Lift Check Valves:
 - a. Hammond/Milwaukee Co.
 - b. Nibco, Inc.
 - c. Stockham/Crane.

9. Balance Valve (2" and smaller Venturi Type):
 - a. Armstrong.
 - b. Flowset-Flow Design Inc.
 - c. Gerand.
 - d. Preso.
 - e. Griswold.
 - f. Victaulic / IMI.

10. Balance Valve (2" and smaller variable CV orifice type):
 - a. Armstrong.
 - b. Bell & Gossett.
 - c. Nibco, Inc.
 - d. Victaulic / IMI.

11. Reduced Pressure Backflow Preventer:
 - a. Apollo.
 - b. Febco Sales, Inc.
 - c. Watts.
 - d. Zurn/Wilkins.

E. Valve Features:

1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping. All valves in the plumbing system shall be lead free.
2. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5, (steel), or ANSI B16.24 (bronze).
3. Threaded: Valve ends complying with ANSI B2.1.
4. Solder-Joint: Valve ends complying with ANSI B16.18.
5. Press Ends: Valve end comply with ANSI B 75 or ANSI B 88 or ASME B16.54.

F. Valve Schedule:

1. General: Provide the following valves for various valve types referenced in Division 22 sections.

2. Drain Valves:
 - a. 125 lb. SWP: Bronze body, stainless ball and stem, , 3/4" hose outlet, provide cap and chain. Cap shall be fully rated to the maximum pressure of the valve body. Conform to ASSE 1005. Lead free.
 - 1) Threaded End:
 - a) Apollo 70LF-14X-HC
 - b) Nibco, Inc. TS-585-80-LF-HC.
 - 2) Solder Ends:
 - a) Apollo 70LF-20X-HC
 - b) NIBCO S-585-80-LF-HC
3. Ball Valves:
 - a. See sizes below. 600 CWP/150 SWP, bronze body, full port, bronze trim, 2-piece construction, TFE seats and seals (NSF 61 - 180° F C. Hot). Lead free.
 - 1) Solder
 - a) 1/2" to 2 1/2": Apollo 77CLF-200A.
 - b) 1/2" to 2": Milwaukee UPBA-450
 - c) 1/2" to 2": Nibco, Inc. S-585-80-LF or S-585HP-LF.
 - 2) Threaded
 - a) 1/2" to 2 1/2": Apollo 77CLF-100A.
 - b) 1/2" to 2": Milwaukee UPBA-400.
 - c) 1/2" to 2": Nibco, Inc. T-585-80-LF or T-585HP-LF.
4. Butterfly Valves:
 - a. 6" and Smaller: 200 psi, cast iron or ductile iron body, lug type, extended neck, CF8M stainless steel or aluminum bronze disc, bearings, reinforced resilient EDPM seat, manual lever and lock, lead free. Conform to MSS SP-67. Butterfly valves shall be capable of bubble tight shut-off at full rated pressure and be rated for bi-directional dead-end service without the need for a downstream flange.
 - 1) Lug:
 - a) Apollo LD141
 - b) Nibco, Inc. LD2000.
5. Swing Check Valves:
 - a. 3" and Smaller: 125 lb. SWP, bronze body, horizontal swing, straight pattern flow renewable disc, lead free. Conform to MSS SP-80.
 - 1) Threaded Ends:
 - a) Apollo 161TLF.

- b) Nibco, Inc. T-413-Y-LF.
- 2) Solder Ends:
 - a) Apollo 161SLF
 - b) Nibco, Inc. S-413-Y-LF.
- 6. Wafer Check Valves:
 - a. All Sizes: 125 psi, cast-iron body, aluminum bronze or plated iron plates, stainless steel stem, Buna-N seat, stainless steel springs, lead free.
 - 1) Apollo 6WC-10X-NILF
 - 2) Nibco, Inc.: W-920-W-LF.
- 7. Lift Check Valves:
 - a. 2" and Smaller: 125 psi, bronze body, lift type, spring loaded, renewable disc, threaded ends, lead free. Conform to FC174-1 for design, rating and testing.
 - 1) Nibco, Inc. T-480-Y-LF.
- 8. Gas Plug Valve:
 - a. 2" and Smaller: 150 psi, cast-iron body, straightaway pattern, square bronze head, threaded ends.
 - 1) DeZurik #PEC.
 - 2) Homestead: 611.
 - b. 2-1/2" and Larger: 175 psi, lubricated or permanently lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.
 - 1) DeZurik #PEC.
 - 2) Nordstrom 143.
 - 3) Powell 2201.
 - 4) Homestead: 611/612.
- 9. Gas Cocks:
 - a. Gas Cocks 3" and Smaller: 250 psi non-shock CWP, bronze ball valve with chrome plated ball, threaded ends, UL listed.
 - 1) Nibco, Inc. T-580-70-UL-842.
 - 2) Apollo 80-100
- 10. Balance Valves:
 - a. (CV Type) 2" Size and Smaller: Provide balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT O-ring seals to prevent leakage around rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on

heating and cooling systems, and to protect balance valves during shipment. Must be lead free.

1) Acceptable Manufacturers:

- a) Armstrong.
- b) Bell & Gossett, ITT; Fluid Handling Div.
- c) Nibco, Inc.
- d) Victaulic / IMI.

- b. (Venturi Type) 2" and Smaller: One piece, non-ferrous, bronze/brass flow measuring and balancing/shut-off valve combination. The flow element shall be a low loss/high signal Venturi type ($\pm 2\%$ accuracy) of one to ten rangeability, equipped with dual Schrader Type pressure test posts and caps. Balancing/shutoff valves shall be ball type with large diameter plated ball, teflon seats, blow out proof stem with teflon packing and packing nut. Full size handle, grip and memory stop. Entire assembly rated to 400 WOG and tested to 100% after assembly. Must be lead free.

1) Acceptable Manufacturers:

- a) Armstrong
- b) Flow Design-Flowset.
- c) Gerand Co.
- d) Griswold (manually adjusted valves only).
- e) Preso.
- f) Victaulic / IMI.

11. Reduced Pressure Backflow Preventer:

- a. Provide reduced pressure principle backflow preventers consisting of assembly including shutoff valves on inlet and outlet, and strainer on inlet. Backflow preventers shall include test cocks, and pressure-differential relief valve located between 2 positive seating check valves. Provide funnel drain assembly and airgap drain to floor drain. Construct in accordance with ASSE Standard 1013, and is USC approved and lead free.

1) FEBCO Co. LF880V (all sizes), LF860 (all sizes).

2.04 PIPING SPECIALTIES

- A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.
- B. Pipe Escutcheons:
1. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or

- ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
 3. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.
 4. Acceptable Manufacturers:
 - a. Brasscraft.
 - b. Dearborn.
 - c. McGuire.
 - d. Zurn.
- C. Air Admittances Valve: Provide an air admittance valve constructed of materials approved for specific application.
1. Sanitary vent system admittance valves shall meet with ASSE 1051.
 2. Acid Vent system admittance valves shall meet ASSE 1049.
 3. Acceptable Manufacturers:
 - a. Studor.
- D. Strainers:
1. General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64" perforations @ 233 per sq. in. as a minimum.
 - a. Flanged Ends, 6" and Smaller in Copper Piping Systems: wye patterned cast copper silicon strainer, screwed screen retainer with centered blowdown fitted and blowdown piped to nearest drain with valve.
 - b. Acceptable Manufacturers:
 - 1) Watts LF7777: 1/4" thru 4".
 - 2) Apollo 59LF Series: 1/8" thru 4".
- E. Dielectric Fittings:
1. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
 2. Dielectric unions and flanges shall conform to ANSI and have no flow restriction when assembled. Flanges shall be rated at 175 psi and unions at 250 psi.
 - a. Acceptable Manufacturers:
 - 1) Capital MFG.
 - 2) Epco Sales, Inc.
 - 3) Mueller Company.
 - 4) Watts Regulator.
 - b. Clearflow dielectric waterway nipple, steel nipple with inert thermoplastic liner. Shall meet ASTM F-492-77.
 - 1) Acceptable Manufacturers:

- a) Gruvlok.
- b) Victaulic.

F. Fire Barrier Penetration Seals:

1. Provide seals for any opening through fire-rated walls, floors, or ceilings used as passage for mechanical components such as piping or ductwork.
 - a. Cracks, Voids, or Holes Up to 4" Diameter: Use putty or caulking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable jackets, and capable of expanding 10 times when exposed to flame or heat, UL-listed.
 - b. Openings 4" or Greater: Use sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 to 350°F (121 to 177°C), UL-listed.
 - 1) VOC content of fire barrier sealant not to exceed 250 g/L.
 - c. Acceptable Manufacturers:
 - 1) Electro Products Div./3M. (Fire Barrier Systems)
 - 2) Mansville Products Corp.
 - 3) Nelson; Unit of General Signal. (Flameseal)
 - 4) Pipe Shield Incorporated.
 - 5) STI.
 - 6) Hilti – FS/One.

G. Water Hammer Arresters:

1. General: Provide piston type water hammer arresters, pressure rated for 250 psi, tested and certified in accordance with ASSE #1010 and lead free. Provide access panel for servicing.
2. Acceptable Manufacturers:
 - a. Josam Co.
 - b. PPP, Inc.
 - c. Sioux Chief.
 - d. Smith (Jay R.) Mfg. Co.
 - e. Watts.
 - f. Zurn Industries, Inc.; Hydromechanics Div.

2.05 FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.
- B. Pipe Sleeves: Provide pipe sleeves of one of the following:
 1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" and smaller, 20 gauge; 4" to 6" 16 gauge; over 6", 14 gauge.

2. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.
4. Plastic-Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.

C. Sleeve Seals: Provide sleeve seals in sleeve as follows:

1. Below grade in foundation wall or exterior walls above grade.
 - a. Link seal.
 - b. Innerlynx.
2. Penetration below grade thru floor.
 - a. Provide elastomeric joint sealant to maintain watertight and airtight continuous seal.
3. Penetrations thru walls, floors, or ceilings above grade.
 - a. Intumescent fire stop.

2.06 PIPE ALIGNMENT GUIDES

- A. General: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated. Construct with 4- finger spider traveling inside guiding sleeve, with provision for anchoring to building substrate.
- B. Acceptable Manufacturers:
 1. Anvil.
 2. Hyspan Precision Products, Inc.
 3. Metraflex Co.

2.07 HANGERS AND SUPPORTS

- A. References:
 1. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 2. ASTM A123 – Specification for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
 3. ASTM A653 G90 – Specification for Steel Sheet, Zinc Coated by the Hot-Dip Process.
 4. MSS SP58 – Manufacturers Standardization Society: Pipe Hangers and Supports – Materials, Design and Manufacture.
 5. MSS SP69 – Manufacturers Standardization Society: Pipe Hangers and Supports – Selection and Application.
- B. Quality Assurance:
 1. Hangers and supports used in fire protection piping systems shall be listed and labeled by Underwriters Laboratories.
 2. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.
 3. Hangers and supports shall be designed and manufactured in conformance with MSS SP58.

4. Supports for sprinkler piping shall be in conformance with NFPA 13.

C. Horizontal-Piping Hangers and Supports:

1. General: Except as otherwise indicated, provide factory- fabricated horizontal-piping hangers and supports selected by Installer to suit horizontal-piping systems. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with **saddle or shield** for insulated piping. Provide baked on epoxy paint hangers and supports for copper piping systems.

D. Vertical-Piping Clamps:

1. General: Except as otherwise indicated, provide factory- fabricated vertical-piping clamps complying with MSS SP-58 selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide baked on epoxy paint clamps for copper-piping systems.

E. Hanger-Rod Attachments:

1. General: Except as otherwise indicated, provide factory- fabricated hanger-rod attachments complying with MSS SP-58 selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

F. Building Attachments:

1. General: Except as otherwise indicated, provide factory- fabricated building attachments complying with MSS SP-58 selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.

G. Finishes:

1. Indoor Finishes:

- a. Hangers and clamps for support of bare copper piping shall be coated with copper colored epoxy paint. Additional PVC coating of the epoxy painted hanger shall be used where necessary.
- b. Hangers for other than bare copper pipe shall be zinc plated in accordance with ASTM B633 or shall have an electrodeposited epoxy finish.
- c. Strut channels shall be pre-galvanized in accordance with ASTM A653 G90 or have an electrodeposited epoxy finish.

2. Outdoor, High Humidity and Corrosive Area Finishes:

- a. Hangers and strut for insulated piping in high humidity areas, including but not limited to; Natatoriums, pool locker rooms and pool equipment rooms, shall be hot dip galvanized after fabrication by manufacturing in accordance with ASTM A123. All hanger hardware in high humidity areas shall also be hot-dip galvanized. Zinc plated or stainless-steel hardware is not acceptable for these areas.

- b. Hangers in direct contact with un-insulated steel or cast-iron piping in high humidity areas, including but not limited to; natatoriums, pool locker rooms, pool chemical rooms and pool equipment rooms, shall be electro-deposit epoxy finish. Attachments, strut, hanger rod and hardware shall be hot-dip galvanized after fabrication by manufacturing in accordance with ASTM A123. Zinc plated or stainless-steel hardware is not acceptable for these areas.
- c. Hangers and struts located in outdoor or corrosive areas, including but not limited to corrosive chemical storage rooms, shall be electro-deposit epoxy finish with stainless steel hardware. (Does not apply to chlorine storage, the chlorine storage room hangers shall match the natatorium.).

H. Acceptable Manufacturers of Hangers and Supports:

- 1. B-Line Systems Inc.
- 2. Superstrut.
- 3. PHD, Inc.
- 4. Erico.

I. Pipe Positioning Systems:

- 1. Description: IAPMO PS42, system of metal brackets, clips and straps for positioning piping in pipe spaces for plumbing fixtures.
- 2. Acceptable Manufacturers:
 - a. Holdrite Corp.; Hubbard Enterprises.

J. Cast Iron Piping Restraints

- 1. Engineered restraints for cast iron piping up to 50 feet of head pressure.
- 2. Acceptable Manufacturers:
 - a. Holdrite Corp.; Hubbard Enterprises.

K. Shields:

- 1. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size **saddles and shields** for exact fit to mate with pipe insulation.
- 2. Protection Shields: MSS Type 40; of length per schedule below to prevent crushing of insulation. Provide coated projection shields on cold/ chilled water piping.

a. Schedule:

Nominal Pipe or Tubing Size	Shield Length	Shield Gauge Thickness	Material
½" thru 3"	12"	18	Galvanized
4"	12"	16	Galvanized

- 3. Thermal Hanger Shields: MSS Type 40 Constructed of an insert of high density, 100 psi, water-proofed calcium silicate, encased in a sheet metal shield. Provide assembly of same thickness as adjoining insulation. The style of thermal hanger shield assembly shall be determined by shield manufacturer based on hanger type.
- 4. Acceptable Manufacturers:
 - a. Pipe Shields, Inc.

- b. Value Engineering Products, Inc.

2.08 MISCELLANEOUS MATERIALS

- A. Metal Framing:
1. Supplementary Structural Supports: Design and fabricate supports using structural quality steel bolted framing materials as manufactured by B-Line Systems. Channels shall be roll formed, 12-gauge ASTM A570 Grade 33 steel, 1 5/8" x 1 5/8" or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to Engineer for approval. Use clamps and fittings designed for use with the strut system.
- B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
- C. Trapeze Hangers:
1. Trapeze hangers shall be constructed from 12-gauge roll formed ASTM A570 Gr. 33 structural steel channel, 1 5/8" x 1 5/8" minimum. B-Line B22 strut or stronger as required.
 2. Mount pipes to trapeze with 2-piece pipe straps sized for outside diameter of pipe, B-Line B2000 Series.
 3. For pipes subjected to axial movement:
 - a. Strut mounted roller support, B-Line B3126. Use pipe protection **saddles or shields** on insulated lines.
 - b. Strut mounted pipe guide, B-Line B2417.
- D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
- E. Pipe Guides: Provide factory-fabricated guides, of cast semi- steel or heavy fabricated steel, consisting of bolted two- section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.09 GLASS THERMOMETERS

- A. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9" long.
- C. Adjustable Joint: Die cast aluminum, finished to match case, 180°F adjustment in vertical plane, 360 degrees adjustment in horizontal plane, with locking device.
- D. Tube and Capillary: Organic filled "red" color, magnifying lens, 1% scale range accuracy, shock mounted.
- E. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
- F. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation and lead free.

- G. Range: Conform to the following:
1. Hot Water: 30° - 240°F with 2°F scale divisions.

- H. Acceptable Manufacturers:
1. Ernst Gauge Co.
 2. Marshalltown Instruments, Inc.
 3. Taylor.
 4. Trerice (H.O.) Co.
 5. Weiss Instruments, Inc.
 6. Winters Thermogauge.

2.10 THERMOMETER WELLS

- A. General: Provide thermometer wells constructed of brass or stainless steel, lead free, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
- B. Manufacturer: Same as thermometers.

2.11 PRESSURE AND TEMPERATURE GAUGE CONNECTOR PLUGS

- A. General: Provide temperature and pressure gauge connector plugs pressure rated for 500 psi and 275°F. Construct of brass and finish in nickel-plate, lead free, equip with 1/2" NPT fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion thermometer or pressure gauge. Equip orifice with gasketed screw cap and retaining strap. Provide extension, length equal to insulation thickness, for insulated piping.
- B. Acceptable Manufacturers:
1. Peterson Equipment Co.

2.12 PRESSURE GAUGES

- A. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Type: General use, 1% accuracy, ANSI B40.1 grade A, phosphor bronze bourdon type, bottom connection.
- C. Case: Drawn steel or brass, glass lens, 4 1/2" diameter.
- D. Connector: Brass with 1/4" male NPT, lead free. Provide protective syphon when used for steam service.
- E. Scale: White coated aluminum, with permanently etched markings.
- F. Range: Conform to the following:
1. Water: 0 - 100 psi.

- G. Acceptable Manufacturers:
1. Ametek/U.S. Gauge.
 2. Marsh Instrument Co.; Unit of General Signal.
 3. Marshalltown Instruments, Inc.
 4. Terice (H.O.) Co.
 5. Weiss Instruments, Inc.
 6. Winters Thermogauge.

2.13 PRESSURE GAUGE COCKS

- A. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4" female NPT on each end, and "T" handle brass plug.
- B. Snubber: 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served, lead free and pressure rating.
- C. Manufacturer: Same as for pressure gauges.

PART 3 EXECUTION

3.01 PIPE AND PIPE FITTING INSTALLATION

- A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of building; limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
- C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.
- D. Painting of Pipe: Paint all exterior steel piping (gas, etc.) with a rust inhibitor paint. Coordinate color with architect prior to painting.

3.02 PIPING SYSTEM JOINTS

- A. General: Provide joints of type indicated in each piping system.

- B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- C. Braze copper tube-and-fitting joints where indicated, in accordance with ASME B31.
- D. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Use only flux with no lead content. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- E. Press Connections: Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.
- F. Weld pipe joints in accordance with recognized industry practice and as follows:
 - 1. Weld pipe joints only when ambient temperature is above 0°F (-18°C) where possible.
 - 2. Bevel pipe ends at a 37.5-degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 - 3. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
 - 4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
 - 5. Do not weld-out piping system imperfections by tack-welding procedures; re-fabricate to comply with requirements.
 - 6. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.
 - 7. Clean all welded joints and apply prime coat rust inhibitor.
- G. Weld pipe joints of steel water pipe in accordance with AWWA C206.
- H. Hubless Hub & Spigot, Cast-Iron Joints: Comply with coupling manufacturer's installation instructions.
- I. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards. Install per ASTM D-2321 (underground installation) with contractor Bunder's Qualification per ASME B31.3.

3.03 INSTALLATION OF VALVES

- A. General: Except as otherwise indicated, comply with the following requirements:
 - 1. Install valves where required for proper operation of piping and equipment, including valves in all branch lines to isolate sections of piping whether shown or not. Branch lines will be considered any line connecting to the main piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
- B. Shutoff Valves: Install on inlet and outlet of each mechanical equipment item, and elsewhere as indicated.
- C. Drain Valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic piping system.
- D. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.
- E. Mechanical Actuators: Install mechanical actuators with chain operators where indicated. Extend chains to about 5' above floor and hook to clips to clear aisle passage.
- F. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.
- G. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.
- H. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.
- I. Fluid Control: Except as otherwise indicated, install ball or butterfly valves to comply with ANSI B31.9. Where throttling is indicated or recognized as principal reason for valve, install balancing valves or as indicated on drawings.
- J. Installation of Check Valves (5x diameter of pipe lay length away from pumps):
 1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.
 2. Wafer Check Valves: Install between 2 flanges in horizontal or vertical position, position for proper direction of flow.
 3. Lift Check Valve: Install in piping line with stem vertically upward, position for proper direction of flow.

3.04 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of pipe connection. Provide drain line from shutoff valve to plumbing drain and airgap, full size of blow down connection.

1. Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:
 - a. Pumps.
 - b. Pressure reducing valves.
 - c. Main domestic water entry prior to backflow.

- C. Dielectric Fittings:
 1. Contractor shall use dielectric nipples wherever possible.
 2. Provide dielectric pipe fittings and isolators at all connections between dissimilar metals in the **domestic water and fire protection systems** to control corrosion potential caused by galvanic or electrolytic action.
 3. Typical locations for dielectric isolation are: **water heaters, storage and pressure tanks, water conditioning equipment, pumps, changes in service piping materials, make-up connections to boilers and chilled water systems, valves, deaerators, flexible connectors** and the like where materials of different electrode potential are joined.
 4. Storage tanks shall be isolated from piping and tank stands by use of anti-electrolytic and galvanic isolators.

- D. Fire Barrier Penetration Seals: Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions.

- E. Water Hammer Arresters: Install in upright position, in locations of all quick closing valves and as required by code, and of sizes in accordance with ASSE #1010, and elsewhere as indicated.

3.05 INSTALLATION OF FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.

- B. Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 1/4" above level floor finish, and 3/4" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.
 1. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings.
 2. Install iron-pipe sleeves at exterior penetrations; both above and below grade.
 3. Install steel-pipe sleeves except as otherwise indicated.

- C. Sleeve Seals: Install in accordance with the manufacturer's requirements.

3.06 EXPANSION LOOP INSTALLATION

- A. General: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by Installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by Installer to properly anchor piping in relationship to expansion loops.

3.07 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings per local code. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Installation of Building Attachments:
 - 1. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69 Table 3 or local code, whichever is more stringent. Install additional hangers at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.
- C. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods, or by plastic coated hangers.
- E. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
 - 2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
- F. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Shield Installation:
 - a. 3" and smaller piping: Contractor option: protection shields or thermal hanger shields. Provide on cold/chilled water a vapor barrier.

- b. 4" and Larger: thermal hanger shields. Provide on cold/chilled water piping a vapor barrier.
- G. Support of pipe, tubing and equipment shall be accomplished by means of engineered products, specific to each application. Makeshift, field devised methods shall not be allowed.
- H. Hangers, struts and hardware in outdoor or high humidity areas including but not limited to; Natatoriums, pool locker rooms, pool chemical rooms and pool equipment rooms, shall be field painted by the general contractor. Coordinate hanger material with painting contractor prior to painting. The installing paint contractor shall provide preparation and painting suitable for the material used.

3.08 INSTALLATION OF ANCHORS AND/OR RESTRAINTS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe- runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.
- E. Provide Restraints on cast-iron that is greater than 4" in size or as required by Codes.
 - 1. Engineered Restraints per Section 22 1000 only.

3.09 EQUIPMENT SUPPORTS

- A. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.10 INSTALLATION OF TEMPERATURE GAUGES

- A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.
- B. Locations: Install in the following locations, and elsewhere as indicated:
 - 1. At outlet of each domestic hot water storage tank and temperature mixing valve.
 - 2. Downstream of hot water recirculation pump.
- C. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

- D. Temperature Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.11 INSTALLATION OF PRESSURE AND TEMPERATURE TEST PLUGS

- A. General: Install in piping where indicated, located on pipe at the most readable position. Secure cap.
- B. For horizontal pipe, install in top half of pipe line.

3.12 INSTALLATION OF PRESSURE GAUGES

- A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated:
 - 1. At suction and discharge of each pump.
 - 2. At discharge of each pressure reducing valve.
 - 3. At water service and fire service entry. Prior to backflow preventer.
- C. Pressure Gauge Cocks: Install in piping tee with snubber.
- D. Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.13 CLEANING, FLUSHING, INSPECTING

- A. General: Clean exterior surfaces of superfluous materials, and prepare for application of specified coatings (if any). Flush out systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
 - 1. Inspect pressure piping in accordance with procedures of ASME B31.
- B. Disinfection of Domestic Water Piping System
 - 1. Disinfect water mains and water service including all new and existing inside building domestic HW, CW and HWC piping.
 - 2. Disinfection of piping and testing shall be completed a minimum of one week prior to occupancy.
 - 3. Prior to starting work, verify system is complete, flushed and clean.
 - 4. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
 - 5. Inject disinfectant free chloride in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/K residual.
 - 6. Bleed water from outlets to ensure distribution and test for disinfectant residual at a minimum 15 percent of outlets.
 - 7. Maintain disinfectant in system for 24 hours.
 - 8. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
 - 9. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
 - 10. Take samples no sooner than 24 hours after flushing, from 5 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

- C. Disinfect water mains and water service including all new inside building domestic HW, CW and HWC piping in accordance with the authority having jurisdiction or, if methods are not prescribed, in accordance with AWWA C651. Disinfection of piping and testing shall be completed a minimum of one week prior to occupancy.

3.14 PIPING TESTS

- A. Test pressure piping in accordance with ASME B31.
- B. General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time. Air may be used if allowed by Code. Air cannot be used for plastic piping.
 - 1. Required test period is 8 hours.
 - 2. Test each piping system at 150% of operating pressure indicated, but not less than 100 psi test pressure.
 - 3. Test drainage piping systems at a nominal pressure of 10 ft. hydrostatic head.
 - 4. Test force drainage (pumped) piping at 50 psi.
 - 5. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
- C. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- D. Drain test water from piping systems after testing and repair work has been completed.

END SECTION

222000
PLUMBING SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 22 1000 "Pipes, Valves and Piping Specialties."

1.02 DESCRIPTION OF WORK

- A. Systems and equipment specified in this section include the following:
1. Potable Water System.
 2. Storm Water, Waste and Vent System.
 3. Natural Gas System.
 4. Plumbing Fixtures.
 5. Plumbing Pumps.
 6. Water Heaters.

1.03 SUBMITTALS

- A. Provide the following submittals:
1. Potable Water Specialties.
 2. Thermostatic Mixing Valves.
 3. Expansion Tank.
 4. Gas Regulators.
 5. Cleanouts.
 6. Drains.
 7. Plumbing Fixtures & Trim.
 8. Pumps.
 9. Water Heaters.

PART 2 PRODUCTS

2.01 MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products, and specified equipment of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide sizes and types matching piping and equipment connections and provide fittings of materials which match pipe materials. Where more than one type of materials or products are indicated, selection is Installer's option.

2.02 PIPES, PIPE FITTINGS AND ACCESSORIES

- A. Basic Valves: Refer to Section 22 1000 for valve and manufacturer Specification.
1. Sectional and Shutoff Valves:
 - a. 2" and Smaller: Ball valves.

- b. 2-1/2" and Larger: Ball valves or butterfly valves.
- 2. Drain Valves:
 - a. 2" and Smaller: Ball valves.
 - b. 2-1/2" and Larger: Ball valves or butterfly valves.
- 3. Check Valves:
 - a. All Sizes: Swing or lift check valves.
- 4. Balancing Valves:
 - a. All sizes: Calibrated or Venturi type only; positive shut-off.

2.03 POTABLE WATER SPECIALTIES

A. Hose Bibbs and Floor Boxes

- 1. HB-1: Chicago Faucet Co. No. 952-CP; Threaded end, chrome plated, bronze body, renewable composition disc, tee handle, 3/4" NPT inlet, 3/4" hose outlet, integral vacuum breaker.
- 2. HB-2: Zurn Z-1350-VB, stainless steel cabinet with door and wall flange, loose key handle, vacuum breaker, coordinate, water proofing.
- 3. FB-1: Woodford #Y95 nickel bronze box and cover, vacuum breaker.
- 4. Acceptable Manufacturers:
 - a. Acorn.
 - b. Chicago Faucet Co.
 - c. Mifab, Inc.
 - d. Prier Co.
 - e. Smith, (Jay R.) Mfg. Co.
 - f. T & S Brass and Bronze Co.
 - g. Zurn.
 - h. Woodfono Mfg. Co.

B. Wall Hydrants

- 1. WH-1: Woodford Model B67; non-freeze cast-bronze/brass box hydrant, polished bronze/brass plated face, tee handle key, bronze casing, length to suit wall thickness, integral vacuum breaker, self-draining, hinged locking cover, 3/4" inlet, hose outlet.
- 2. Acceptable Manufacturers:
 - a. Josam Mfg. Co.
 - b. Mifab, Inc.
 - c. Smith, (Jay R.) Mfg. Co.
 - d. Woodford Mfg. Co.
 - e. Watts Co.
 - f. Zurn Industries Inc., Hydromechanics Div.

C. Roof Hydrants

- 1. RH-1: Woodford #SRH-MS, non-freeze, automatic draining reservoir, built-in vacuum breaker, cast-iron deck support and flange, secured in roof deck, roof flashing.
- 2. Acceptable Manufacturers:

- a. Josam Mfg. Co.
- b. Mifab, Inc.
- c. Smith, (Jay R.) Mfg. Co.
- d. Woodford Mfg. Co.
- e. Zurn.
- f. MAPA Products (Roof hydrants only).

D. Connection Outlet

1. Ice Maker Box (IMB-1): Sioux Chief #696-G101, white ABS, Type L copper, "AA" water hammer arrestor, face plate, Lead free.
2. Washer Box (WB-1): Sioux Chief #696-G2313, white ABS, Type L copper, "AA" water hammer arrestor face plate, Lead free.
3. Acceptable Manufacturers:
 - a. Sioux Chief.
 - b. IPS Corporation.
 - c. Oatey.
 - d. Proset Systems.

E. Backflow Preventers

1. Refer to Section 22 1000 for Specification.

F. Relief Valves

1. Provide relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.
2. Acceptable Manufacturers:
 - a. Cash (A. W.) Valve Mfg. Corp.
 - b. Conbraco Industries, Inc.
 - c. Watts Regulator Co.
 - d. Zurn Industries, Inc.; Wilkins-Regulator Div.

G. Water Hammer Arresters

1. Refer to Section 22 1000 for Specification.

H. P-Trap Supplies, Stops & Supply Insulation Kits

1. Approved Manufacturers:
 - a. Brass Craft.
 - b. Dearborn.
 - c. McQuire Manufacturing.
 - d. PlumberEx.
 - e. Truebro.

I. Trap Primers

1. Provide bronze trap primer valve with automatic vacuum breaker, complying with ASSE 1018, with ½" connections matching mating piping system.
2. Acceptable Manufacturers:

- a. Josam Mfg. Co.
- b. MiFab.
- c. Precision Plumbing Products, Inc.
- d. Sioux Chief
- e. Smith (Jay R.) Mfg. Co.
- f. Tyler Pipe; Subs. of Tyler Corp.
- g. Watts Regulator Co.
- h. Zurn Industries, Inc.; Hydromechanics Div.

J. Water Pressure Regulating Valves

1. Provide pressure regulating valves, single seated, direct operated type, bronze body, integral strainer, complying with requirements of ASSE Standard 1003 and lead free. Size for maximum flow rate and inlet and outlet pressures indicated on drawings.
2. Acceptable Manufacturers:
 - a. Mueller Mfg. Co.
 - b. Watts Regulator Co.
 - c. Zurn/Wilkins.

K. Water Meter

1. Provide meter of size and capacity indicated. Provide roughing-in and bypass for meter in accordance with Utility Company Requirements. Coordinate with utility company for approved meter manufacturers. Provide manufacturers listed below only if utility company does not have recommended manufacturers.
2. Acceptable Manufacturers:
 - a. Badger Meter, Inc.
 - b. Hersey Products Inc.
 - c. Neptune Water Meter Co.; Subs. Neptune Intl.
 - d. Rockwell Intl.; Municipal & Utility Div.
 - e. Sensus.

2.04 THERMOSTATIC MIXING VALVE

A. Master Mixing Valve:

1. Provide lead free thermostatic mixing valve or assembly ASSE 1017 listed, to include thermostatic three-way mixing valve(s), if required, pressure reducing valve, pressure gauges, union inlet strainer checkstops, dial thermometer, shut-off ball valves and all interconnecting piping. Valve(s) shall provide protection against hot or cold supply line failure and thermostatic failure. Valve(s) shall meet drawing scheduled requirements.

B. Point of Use Mixing Valve

1. Provide lead free thermostatic mixing valve, checkstops, ASSE 1070 listed, and located in a serviceable location.

C. Emergency Fixture Mixing Valve:

1. Thermostatic mixing valve system for supplying tempered water to emergency fixtures shall have a tamper-resistant factor set point of 85°F (29°C), union strainer checkstops and an outlet thermometer. It shall include dual internal cold-water bypass and pressure

based external bypass to ensure flow in the event of valve failure or loss of hot water supply. The valve shall provide precise temperature control, capable of compliance to the control accuracy requirements of ASSE 1071. It shall effectively shut down in the event of cold-water failure.

- D. Acceptable Manufacturers:
1. Lawler.
 2. Leonard Valve Company.
 3. MCC Powers Process Controls.
 4. Symmons.
 5. Bradley.
 6. Watts.

2.05 DIAPHRAGM-TYPE EXPANSION TANKS

- A. General: Provide diaphragm expansion tanks of size and number as indicated. Construct tank of welded steel, constructed, tested, and stamped in accordance with Section VIII of ASME Boiler and Pressure Vessel Code for working pressure of 125 psi and lead free. Furnish National Board Form U-1 denoting compliance. Provide specially compounded heavy-duty butyl flexible diaphragm securely sealed into tank to permanently separate air charge from system water, and to maintain design expansion capacity. Provide pressure gauge and air-charging fitting, and drain fitting.
- B. Acceptable Manufacturers:
1. Amtrol, Inc.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett ITT.

2.06 GAS PRESSURE REGULATORS

- A. General Requirements:
1. Single stage and suitable for natural gas.
 2. Steel jacket and corrosion resistant components.
 3. Elevation compensator.
- B. Pressure Regulators (Service or Line): "Natural Gas" Comply with ANSI Z21.80. Subject to compliance with requirements, provide as indicated on the Drawings.
1. End connections: Threaded for regulators 2" and smaller; flanged for regulators 2-1/2" and larger.
 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 10. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping. Regulator may include vent limiting device instead of vent connection if approved by authorities having jurisdiction.
 11. Maximum Inlet Pressure: See Drawings.
 12. Outlet Pressure: See Drawings and Equipment Schedules.
 13. Approved Manufacturers:
 - a. American Meter Company.
 - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - c. Itron, Inc.
- C. Pressure Regulators (Appliance): "Natural Gas" Comply with ANSI Z21.18. Subject to compliance with requirements, provide as indicated on the Drawings.
1. End connections: Threaded for regulators 2" and smaller; flanged for regulators 2-1/2" and larger.
 2. Body and Diaphragm Case: Die-cast aluminum.
 3. Springs: Zinc-plated steel.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 7. Atmospheric Vent: Regulator may include vent limiting device instead of vent connection if approved by authorities having jurisdiction.
 8. Maximum Inlet Pressure: See Drawings.
 9. Outlet Pressure: See Drawings and Equipment Schedules.
 10. Approved Manufacturers:
 - a. American Meter Company.
 - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - c. Maxitrol.
 - d. Itron, Inc.

2.07 STORM DRAIN, WASTE AND VENT SYSTEM

- A. General: Provide pipes and pipe fittings complying with Division 22, Section 22 1000.
- B. Floor Drain, Floor Sinks, Roof Drain, Area Drains and Vent Flashing: Flashing (safe pan) shall consist of one of the following:
1. 4 lb./ft² sheet lead with appropriate under support.
 2. No. 24 B & S gauge (.02) sheet copper with 15 lb. asphalt felt sub pans (silver soldered seams only).
 3. .04 thickness non plasticized chlorinated polyethylene and asphalted saturated felt flashing as approved and acceptable with jurisdictional code.
- C. Drainage Piping Products: Provide factory-fabricated drainage piping products of size and type indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements and governing regulations.
1. Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.

2. Floor Cleanouts: Cast-iron body and frame; cleanout plug; adjustable round top as follows:
 - a. (General) Nickel-Bronze Top: Manufacturers standard cast unit of the pattern indicated:
 - 1) Pattern: Exposed flush type, standard non-slip scored or abrasive finish.
 3. Grade Cleanouts: Cast-iron body and frame; cleanout plug; adjustable round top as follows:
 - a. Cast-iron Top: Manufacturers standard cast unit of the pattern indicated:
 - 1) Pattern: Exposed flush type, standard non-slip scored or abrasive finish.
 4. Wall Cleanouts: Cast-iron body adaptable to pipe with cast-bronze or brass cleanout plug; stainless steel cover including screws.
 5. Acceptable Manufacturers:
 - a. Josam Mfg. Co.
 - b. Mifab, Inc.
 - c. Sioux Chief.
 - d. Smith (Jay R.) Co.
 - e. Tyler-Wade.
 - f. Watts Co.
 - g. Zurn Industries Inc.
- D. Floor Drains and Floor Sinks:
1. General: Provide factory-fabricated drains of size and type indicated. Where not indicated, provide proper selection as determined by Architect/Engineer to comply with installation requirements and governing regulations.
 2. Floor Drains and Floor Sinks:
 - a. Floor Drain (FD-1): Josam No. 30000-A, cast-iron body, flashing collar, weep holes, satin 5" Diameter Nikaloy strainer.
 - b. Floor Drain (FD-2): Sioux Chief #Fat Max-860, PVC grate and body, bottom outlet, flashing flange. No lift handle.
 - c. Floor Sink (FS-1): Josam No. 49320A-NB-AS, cast iron body, flashing flange acid resisting interior, weep holes, aluminum dome strainer, 12-1/2" square top, 6" deep, 1/2" grate.
 - d. Floor Sink (FS-2): Sioux Chief #Square Max 861-_P2, pvc grate and body, bottom outlet, flashing flange. Square top, 14"x14".
 3. Roof Drains, Area Drains & Downspout Nozzles:
 - a. Combination Roof/Overflow Drain (CRD-1): Zurn No. Z100C-C-DU-ULP, cast iron body, clamp ring w/gravel stop, bottom outlets, deck clamp, cast iron domes.
 - b. Area Drain (AD-1): Same as FD-2 above, less p-trap.
 - c. Downspout Nozzle (DSN-1): Josam #25010 Series, cast bronze downspout nozzle, loose wall flange and inlet threaded connection.
 - d. Acceptable Manufacturers:
 - 1) Josam Mfg. Co.
 - 2) Mifab, Inc.

- 3) Sioux Chief.
 - 4) Smith (Jay R.) Mfg. Co.
 - 5) Tyler Pipe; Subs. of Tyler Corp.
 - 6) Watts Co.
 - 7) Zurn Industries, Inc.; Hydromechanics Div.
4. Non-Metallic Trench Drains: Polymer concrete or high-density polyethylene, interlocking design with pre-sloped or non-sloped bottom radius as plans indicate.
- a. Channel Sections: Interlocking joint, modular units with end caps. Includes flat, round or included bottoms with level, invert and with outlet numbers, sizes and locations.
 - b. Grates: As indicated in detail on drawings. Color of trench and grate shall be approved by Architect at no additional cost. Channels shall fit recesses in channel sections with no more than 1/8" tolerance to channel or concrete slab.
 - c. Accessories:
 - 1) Provide manufacturer's standard supports, anchors, and setting devices.
 - 2) Provide channel-section joining and fastening materials per manufacturer.
 - 3) Provide layout drawings for Engineer/Architect approval. Drawings should show locations, lengths, and installation detail with concrete support, etc.
 - d. Acceptable Manufacturers:
 - 1) ACO.
 - 2) Dura Trench
 - 3) Jay R. Smith.
 - 4) Mifab, Inc.
 - 5) Poly Drain.
 - 6) Zurn Industries.

2.08 NATURAL GAS SYSTEM

- A. General: Provide pipes and pipe fittings complying with Division 22, Section 22 1000.

2.09 PLUMBING FIXTURES

- A. General: Provide factory-fabricated fixtures of type, style and material indicated. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer.
- B. Materials:
1. General: Unless otherwise specified, comply with applicable Federal Specification WW-P-541/-Series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/-specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps, and vacuum breakers, even though some plumbing fixtures specified in this section are not described in WW-P-541.
 2. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface imperfections on finished units are not acceptable.
 3. Where fittings, trim and accessories are exposed or semi-exposed provide bright chrome-plated or polished stainless-steel units. Provide copper or brass where not exposed.

4. Stainless Steel Sheets: ASTM A 167, Type 302/304, hardest workable temper.
 - a. Finish: No. 4, bright, directional polish on exposed surfaces.
5. Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks; glaze exposed surfaces, and test for crazing resistance in accordance with ASTM C 554.
6. Synthetic Stone: High quality, free from defects, glaze on exposed surfaces, stain resistant.

2.10 PLUMBING FITTINGS, TRIM AND ACCESSORIES

- A. General: All components in the plumbing system shall be lead free.
- B. Water Outlets: At locations where water is supplied by manual, automatic or remote control, provide commercial quality faucets, valves, or dispensing devices, of type and size indicated, and as required to operate as indicated. Include manual shutoff valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems.
 1. Vacuum Breakers: Provide with flush valves where required by governing regulations, including locations where water outlets are equipped for hose attachment.
- C. P-Traps: Include removable, 17-gauge, chrome plated P-traps with brass nuts, where drains are indicated for direct connection to drainage system.
- D. Carriers: Provide cast-iron supports for fixtures of either graphitic gray iron, ductile iron, or malleable iron.
- E. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.
- F. Escutcheons: Where fixture supplies and drains penetrate walls in exposed locations, provide chrome-plated cast-brass escutcheons with set screw.
- G. Aerators: Provide aerators of types approved by Health Departments having jurisdiction.
- H. Comply with additional fixture requirements contained in fixture schedule.
- I. Faucet/trim shall meet ANSI 117.1 Section 4.20.4.
- J. Acceptable Manufacturers:
 1. Plumbing Fixtures (Vitreous China):
 - a. American Standard; U.S. Plumbing Products.
 - b. Kohler Co.
 - c. Sloan.
 - d. Toto.
 - e. Zurn.
 2. Lavatory Trim:
 - a. Chicago.
 3. Sink Trim:
 - a. Chicago.

- b. Delta.
- 4. Flush Valves (Diaphragm):
 - a. Sloan Valve Co.
- 5. Fixture Seats:
 - a. Bemis Mfg. Co.
 - b. Beneke Corp.
 - c. Church Products.
 - d. Kohler Co.
 - e. Olsonite Corp.; Olsonite Seats.
 - f. Toto.
- 6. Drinking Fountains:
 - a. Elkay Mfg. Co.
 - b. Halsey Taylor Div.
 - c. Haws Drinking Faucet Co.
 - d. Murdock Manufacturing.
- 7. Mop Basin/Shower Base (Molded Stone):
 - a. Fiat Co.
 - b. Florestone.
 - c. Mustee.
 - d. Zurn.
- 8. Stainless Steel Sinks:
 - a. Elkay Mfg. Co.
 - b. Just Mfg. Co.
 - c. Kohler.
- 9. Shower Trim:
 - a. Bradley Corp.
- 10. Fixture Carriers:
 - a. Josam Mfg. Co.
 - b. Mifab, Inc.
 - c. Smith Co.
 - d. Tyler-Wade.
 - e. Watts Co.
 - f. Zurn Industries, Inc.; Hydromechanics Div.
- 11. Emergency Showers/Eyewashes:
 - a. Acorn
 - b. Bradley Co.
 - c. Guardian Brass Co.
 - d. Haws Co.
 - e. Speakman Co.

2.11 PUMPS

- A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

- B. In-line Recirculation Pumps:
 - 1. General: Provide in-line recirculation pumps where indicated, and of capacities as scheduled.
 - 2. Type: Horizontal, oil-lubricated, designed for 125 psi working pressure, 225°F (107°C) continuous water temperature, and specifically designed for quiet operation.
 - 3. Body: Bronze or stainless-steel construction.
 - 4. Shaft: Steel, ground and polished, integral thrust collar.
 - 5. Bearings: Two horizontal sleeve bearings designed to circulate oil.
 - 6. Seal: Mechanical, with carbon seal face rotating against ceramic seat.
 - 7. Motor: Non-overloading at any point on pump curve, open, drip- proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.
 - 8. Coupling: Self-aligning, flexible coupling.
 - 9. Acceptable Manufacturers:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett ITT; Fluid Handling Div.
 - c. Grundfos.
 - d. Paco Inc.
 - e. Taco, Inc.

2.12 SUBMERSIBLE SUMP PUMPS AND SEWAGE EJECTORS

- A. General: Provide submersible sump pumps and sewage ejectors as indicated, of size and capacity as scheduled.

- B. Pump: Cast-iron shell, cast iron impeller, stainless steel shaft, factory-sealed grease lubricated ball bearings and double mechanical seals.

- C. Motor: Hermetically sealed, **air filled or oil filled** design with built-in overload protection, electrical characteristics as scheduled.

- D. Controls: Mechanical float switches (no mercury) with galvanized rod and switch mounting plate or wall support bracket as indicated on the plans.

- E. Control Panel: Duplex panel in NEMA 1 enclosure. Panel to have hinged door and shall include:
 - 1. Fused disconnect switches with lock-out handles through cover.
 - 2. Magnetic starters with OL and LV protection.
 - 3. Test-off-automatic selector switches.
 - 4. Electric Alternator.
 - 5. Control circuit transformers.
 - 6. Green pump running lights.
 - 7. OL reset buttons.
 - 8. Alarm silencing switch.
 - 9. Terminal Switch.
 - 10. Remote dry contacts for pump trouble with hot water alarm to DDC.

- F. Provide remote alarm panel for high water condition with alarm bell and alarm light with flasher.
- G. Provide submersible sewage ejectors with quick remove system including floor discharge elbow, stainless steel lifting rope and upper guide pipe bracket.
- H. Acceptable Manufacturers:
 - 1. E. Myers.
 - 2. Hydro-Matic Co.
 - 3. Paco Pump Co.
 - 4. Weil Pump Co.
 - 5. Zoeller Co.

2.13 DOMESTIC WATER HEATER

- A. Commercial Gas-Fired Water Heaters (Gas-Fired)
 - 1. General: Provide commercial fully condensing design (94% to 99%) gas-fired water heaters of sizes and capacities as indicated on schedule. Provide U.L Listed and meet efficiency requirements of ASHRAE/IES 90.1b-1992. This heater shall be listed by SCAQMD Rule 1146.2 Low NOx.
 - 2. Heater: Construct for working pressure of 160 PSI; boiler type hand hole cleanout; aluminum anode rod; 3/4" tapping for relief valve; glass lining on internal surfaces exposed to water.
 - 3. Controls: the control shall be an integrated solid-state temperature and ignition control device with integral diagnostics, LED fault display capability and a digital display of temperature settings.
 - 4. Direct Venting: The heater(s) shall be suitable for venting PVC, ABS and/or CPVC for sealed combustion direct venting. The heater shall be factory assembled and tested. The power burner shall be of a design that requires no special calibrations on start up. The heater(s) shall be approved for 0" clearances to combustibles.
 - a. Freeze protection system having spring loaded damper power to open and spring to close.
 - 5. Jacket: Insulate tank with vermin-proof glass fiber or foam insulation. Provide outer steel jacket with baked enamel finish over bonderized undercoating.
 - 6. Accessories: Provide brass drain valve; 3/4" ASME pressure and temperature relief valve, ASME rated construction and cold-water dip tube or vacuum relief valve (Watts #N36-M1) piped above tank.
 - 7. Provide JJM Boiler Works #JM Series or Axiom #NC-1 Condensate Neutralizing Tube for condensing flues and combustion chambers. Pipe to nearest floor drain.
 - 8. Acceptable Manufacturers:
 - a. Bradford – White.
 - b. PVI Industries, Inc.
 - c. Rheem Water Heater.
 - d. Smith Corp. (A.O.); Consumer Products Div.
 - e. State Water Heater.
- B. Electric Water Heaters
 - 1. General: Provide electric water heaters of sizes, capacities, and electrical characteristics as indicated on schedule.

2. Heater: Construct for working pressure of 150 PSI; aluminum anode rod; glass, poly or epoxy lining on internal surfaces exposed to water.
3. Heating Elements: Low watt density with zinc plated copper sheath; double element, non-simultaneous operation.
4. Safety Controls: Equip with high temperature cutoff for each element, factory wired.
5. Jacket: Equip with full size control compartments with front panel opening. Insulate tank with vermin-proof glass fiber or foam insulation. Provide outer steel jacket with baked enamel finish.
6. Accessories: Provide brass drain valve; 3/4" ASME T & P relief valve; cold water dip tube and cold-water dip tube or vacuum relief valve (Watts #N36-M1) piped above tank.
7. Controls: Provide thermostat for each element, factory wired.
8. Acceptable Manufacturers:
 - a. Bradford – White.
 - b. Lochinvar Water Heater Corp.
 - c. Rheem Water Heater.
 - d. Smith Corp. (A.O.); Consumer Products Div.
 - e. State Industries Inc.

C. Commercial Electric Water Heaters (Electric)

1. General: Provide commercial electric water heaters of sizes, capacities, and electrical characteristics as indicated on schedule.
2. Heater: Working pressure of 150 PSI, aluminum anode rod; glass lining on internal surfaces exposed to water.
3. Heating Elements: Heavy-duty, medium watt density, with nikaloy sheath, thermostat stepped through magnetic contactors.
4. Safety Controls: Double pole, manual reset, high limit; probe type electric low water cutoff; both factory-wired.
5. Jacket: Equip with full size control compartments with front panel opening. Insulate tank with vermin-proof glass fiber or foam insulation. Provide outer steel jacket with bonderized undercoat and baked enamel finish.
6. Accessories: Provide brass drain valve; 3/4" ASME temperature and pressure relief valve; ASME tank construction for 125 PSI working pressure; and 4" x 6" hand hole cleanout, NSF rated and cold-water dip tube or vacuum relief valve (Watts #N36-M1) piped above tank.
7. Controls: Adjustable immersion thermostat; power circuit fusing; pilot light and switch controlling control circuit; 3-stage time delay sequencer; and 7-day time clock.
8. Acceptable Manufacturers:
 - a. Bradford – White.
 - b. PVI Industries, Inc.
 - c. Rheem Water Heater.
 - d. Smith Corp (A.O.); Consumer Products Div.
 - e. State Industries, Inc.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which piping systems are to be installed. Verify actual locations of equipment, fixtures and/or piping connections prior to installation. Also examine floors and substrates, and conditions under which work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF INTERIOR WATER PIPING

- A. Install piping level with no pitch.
- B. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- C. Refer to Section 22 1000 for hanger and support requirements.

3.03 INSTALLATION OF EXTERIOR WATER PIPING

- A. General: Install water service piping system in compliance with local governing regulations.
- B. Street Main Connection: Arrange and pay for tap in water main, of size and in location indicated, by Local Water Utility Company.
- C. Street Main Connection: Cut into and install new tee for water service in existing water main, at location indicated, in accordance with local Water Utility Company requirements. Provide curb valve and curb box as indicated.
- D. Water Service Piping: Extend water service piping of size and in location indicated to water service entrance at building. Provide sleeve in foundation wall for water service entry; make entry watertight. Provide shutoff valve at water service entry inside building; strainer, pressure gauge, test tee with valve.

3.04 INSTALLATION OF CONDENSATE PIPING

- A. Route piping to open waste receptacle (i.e. floor drain, floor sink, mop service basin) or to roof drain, or on to roof or grade per Local Code. If on to grade, do not discharge over walkway.
- B. Contractor shall provide acid neutralization tank (container) and all associated flue, boiler and water heater acid condensate connections, including backflow preventer and water connection, as required per the equipment manufacturer. Route piping to acid neutralization vessel and air gap discharge to floor drain or floor sink.

3.05 INSTALLATION OF BACKFLOW PREVENTERS

- A. Install backflow preventers where indicated, and where required by governing authority having jurisdiction. Locate in same room as equipment being protected. Pipe relief outlet to nearest floor drain.

3.06 INSTALLATION OF PRESSURE REGULATING VALVES

- A. Install pressure regulating valves where indicated. Provide inlet and outlet shutoff valves, and throttling valve bypass. Provide pressure gauge on valve outlet. Refer to details on drawings.

3.07 INSTALLATION OF WATER METER

- A. Install water meter in accordance with local utility companies' installation instructions, and comply with requirements.

3.08 INSTALLATION OF UNDERGROUND STORM AND SANITARY SEWER PIPING EXTERIOR TO BUILDING

- A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.
- B. Utility Connections: Provide new tap connection to existing Sanitary Sewer Utility main as indicated. Coordinate tap requirements with governing sanitary district, provide all materials and labor necessary to comply with such requirements.
- C. On-Site Storm Sewer Utility Connections: Make connections to existing piping so that finished work will conform as nearly as practicable to requirements specified for new work.
- D. Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.
- E. Lay piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert.
- F. Place bell ends or groove ends of piping facing upstream.
- G. Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.
- H. Polyvinyl Chloride (PVC) Pipe: Install in accordance with manufacturer's installation recommendations, and in accordance with ASTM D2321.
- I. Cleaning Piping: Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.
 - 1. Place plugs in ends of uncompleted conduit at end of day or whenever work stops.

3.09 INSTALLATION OF UNDERGROUND STORM AND SANITARY DRAIN PIPING WITHIN BUILDING

- A. General: Install underground building drains as indicated and in accordance with International Plumbing Code. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- B. All soil and waste piping: Shall be run at a slope of not less 1/4" per foot (2.08%) for piping up to 4" in size. All piping 4" and over shall be run at a slope of not less than 1/8" (1.04%) per foot unless noted otherwise on Drawings. All storm drain piping shall be run at slopes indicated on the drawings.
- C. Polyvinyl Chloride (PVC) Pipe: Install in accordance with manufacturer's installation recommendations, and in accordance with ASTM D2321 (solid core Schedule 40 PVC only).
- D. Provide either stainless steel waste piping or coated cast iron waste piping on dishwasher discharge line for the first 20' downstream of dishwasher discharge.

3.10 INSTALLATION OF ABOVE GROUND STORM AND SANITARY DRAIN, WASTE AND VENT PIPING WITHIN BUILDING

- A. General: Install all piping, as indicated and in accordance with the International Plumbing Code.
- B. Provide restraints and hangers as appropriate and in accordance with manufacturers recommendations based upon type of pipe, fittings, joints. Refer to Section 22 1000.
- C. Piping shall be run true, plumb, and straight, with all restraints and hangers adjusted to carry their proportional load and locked to prevent pipe "wag", misalignment, movement or shear.
- D. Provide anchors for piping risers on every floor using riser clamps, wall brackets, knee brackets, and foot blocks for all vertical piping over 20 feet straight height.
- E. All soil and waste piping shall be run at a slope of not less than 1/4" per foot (2.08%) for piping up to 4" in size. All piping 4" and over shall be run at a slope of not less than 1/8" (1.04%) per foot unless noted otherwise on Drawings. All storm drain piping shall be run at slopes indicated on the drawings.
- F. Bushings in soil waste or vent piping shall be prohibited. Tapped spigots or tees shall be used when changing from cast iron pipe to DWV waste or vent piping, and for appropriate cleanout plugs.
- G. All horizontal storm soil, waste and vent piping shall be supported from the building structure at not more than five (5) foot intervals. Cast iron no-hub pipe and fittings shall be supported within one foot of each side of couplings. All vertical storm soil and vent stacks shall be supported with riser clamps at each floor slab.
- H. The waste connections between fixtures and their respective collection and venting systems shall consist of DWV nipples and drainage fittings.
- I. All interior waste and vent piping up to 1 1/4" shall consist of DWV copper with drainage fittings. All 1-1/2" piping can be either DWV copper or cast-iron. All piping 2" and over shall consist of service weight cast-iron soil pipe and fittings.
- J. All cast iron pipe and fittings shall have affixed thereon the CISPI grade mark of identification.
- K. All vents protruding through the roof shall be not less than 3" size and extended to not less than 12" above the finished roof, and flashed with 24" x 24" x 4 lb. sheet lead. The flashing shall extend not less than 6" above the roof and the edges turned down into a hub type cast iron vent pipe, caulked in place and finished with hot poured lead or per roof membrane manufacturer's requirements.
- L. All vents shall be located in accordance with jurisdictional code and in no case less than two (2) feet from roof edge or parapet, or wall line of an "on the roof structure".
- M. Provide all expansion joints, braces, earthquake restraints as required by the contract documents and jurisdictional authority.
- N. Provide heavy duty couplings on cast-iron no-hub drainage piping above nursery, computer rooms, base of waste stack more than two (2) stories in height, and storm piping with more than 10' of head.
- O. Provide either stainless steel waste piping or coated cast iron waste piping on dishwasher discharge line for the first 20' downstream of dishwasher discharge.

3.11 INSTALLATION OF DRAINAGE PIPING PRODUCTS

- A. Cleanouts: Install in above ground piping and building drain piping as indicated, as required by International Plumbing Code; and at each change in direction of piping greater than 45 degrees; at minimum intervals of 50' for piping 3" and smaller and 100' for larger piping; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping. Wall cleanouts shall be installed at a maximum height of 1'-6" above finished floor unless otherwise indicated or directed on the plans.

3.12 INSTALLATION OF BACKWATER VALVES

- A. Install backwater valves in building drain piping as indicated, and as required by governing authorities having jurisdiction. For interior installation, provide cleanout cover flush to floor centered over backwater valve cover, and of adequate size to remove valve cover for service.

3.13 INSTALLATION OF FLOOR DRAINS, FLOOR SINKS AND AREA DRAINS

- A. General: Install floor drains, floor sinks and area drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Coordinate flashing work with work of waterproofing and adjoining substrate work.
- C. Cover all drain strainers during building construction with heavy-duty tape similar to duct tape.
- D. Install drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
- E. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Provide flashing (safepan) for each floor drain above grade, 24"x24" in size.

3.14 INSTALLATION OF TRAP PRIMERS

- A. General: Install trap primers in accordance with manufacturer's installation instructions. Pitch piping towards drain trap, minimum of 1/8" per floor (1%), adjust trap primer for proper flow. Provide trap primers as required by local code authorities and at all floor drains where loss of trap seal due to evaporation exists.

3.15 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide soil and waste piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by International Plumbing Code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.
- C. Upon completion of installations, flush all traps and fill with water.

3.16 INSTALLATION OF ROOF DRAINS

- A. General: Install roof drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Coordinate flashing work with work of roofing, water-proofing and adjoining substrate work.
- C. Provide flashing (safe pan) for each roof drain, 36" x 36" in size.
- D. Coordinate with roofing as necessary to interface roof drains with roofing work.
- E. Install roof drains at low points of surface areas to be drained, or as indicated.
- F. Install drain flashing collar or flange so that no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
- G. Position roof drains so that they are accessible and easy to maintain.
- H. During application of roofing, plug all roof drains with test plugs, remove plugs after roofing has cured.
- I. Securely lock roof drain domes in place upon completion of construction.

3.17 INSTALLATION OF PLUMBING FIXTURES

- A. General: Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of governing authority having jurisdiction pertaining to installation of plumbing fixtures.
- B. Fasten plumbing fixtures securely to indicated supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement.
- C. Protect installed fixtures from damage during remainder of construction period.

3.18 FIELD QUALITY CONTROL FOR FIXTURES

- A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
- B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect/Engineer. Remove cracked or dented units and replace with new units.

3.19 ADJUSTING AND CLEANING OF FIXTURES

- A. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation.

- B. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream and specified gpm.
- C. Adjust or replace washers to prevent leaks at faucets and stops.

3.20 INSTALLATION OF NATURAL GAS PIPING

- A. Use sealants on metal gas piping threads which are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.
- B. Comply with NFPA 54 and International Gas Code for installation, purging and accidental ignition.
- C. Remove cutting and threading burrs before assembling piping.
- D. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.
- E. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.
- F. Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.
- G. Install drip-legs in gas piping where indicated, and where required by code or regulation.
- H. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.
- I. Use dielectric unions where dissimilar metals are joined together.
- J. Install piping with 1/64" per foot (1/8%) downward slope in direction of flow.
- K. Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and steam or hydronic piping above 200°F (93°C).
- L. For piping underground beneath buildings, install in welded conduit. Extend conduit inside and terminate in accessible portion of building and seal. Extend conduit outside minimum of 4" from building, and vent above grade.
- M. For risers running through concrete or asphalt, install through pipe sleeve to a minimum of 6" above grade and vent at both ends. Fill annular space with gravel.
- N. Install magnesium anodes for underground steel pipe, one-5 lb. anode for up to 100' in length and one-5 lb. anode for each additional 100'.
- O. Install magnesium anodes for each underground steel or malleable- iron fitting, isolated between 2 sections of plastic pipe; one-3 lb. anode for each fitting.
- P. For underground piping, provide insulating flange or union above ground prior to entering building above grade.
- Q. Refer to Section 22 1000 for hanger and support requirements.

3.21 INSTALLATION OF GAS SERVICE

- A. General: Arrange with Utility Company to provide gas service to building including gas meter, regulator, service shut-off valve, and gas load within 30 days after award of contract. Consult with Utility as to extent of its work, costs, fees and permits involved. Pay such costs and fees; obtain permits. Costs for actual installation of service and setting of meter by the utility company shall be paid by the owner. Coordinate size of concrete pad or wall brackets for utility company to set meter.
- B. Extend building service line from gas meter into building. Provide full size plug valve on downstream side of meter. Enter building at a minimum of 12" above grade.
- C. Provide shutoff outside building where indicated, in adjustable gas service valve box, with cover set flush to finished grade.
- D. Provide shutoff in gas service pipe at entry in building, extend pipe to gas meter location indicated; provide parts and accessories required by Utility to connect meter.

3.22 INSTALLATION OF GAS VALVES

- A. Gas Cocks: Provide at connection to gas train for each gas-fired equipment item; and on risers and branches where indicated.
- B. Locate gas cocks where easily accessible, and where they will be protected from possible injury.
- C. Pressure Regulating Valves: Install as indicated; comply with Utility requirements. Pipe atmospheric vent to outdoors, full size of outlet. Install gas shutoff valve upstream of each pressure regulating valve.
- D. Verify venting requirements for pressure regulating valves in factory installed or factory supplied valve trains. Extend atmospheric vent to outdoors, full size of vent outlet when equipment is controlled by spark ignition. When equipment has standing pilot, pipe regulator vent(s) to combustion chamber. Verify regulator venting requirements with local authority prior to installation.

3.23 INSTALLATION OF PUMPS

- A. General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that plumbing pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around plumbing pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Support: Install base-mounted pumps on minimum of 4" high concrete base equal or greater than 3 times total weight of pump and motor, with anchor bolts poured in place. Set and level pump, grout under pump base with non-shrink grout.
- D. Install in-line pumps, supported from piping system.

3.24 INSTALLATION OF SUMP PUMPS AND SEWAGE EJECTORS

- A. Coordinate electrical power and control wiring, panel mounting and remote and local alarm systems wiring with Division 26 Contractor.
- B. All openings through basin or cover to be gas tight, provide unions, valves and checks as appropriate. Note: pump discharge check valves to be non slam type, tilting disc or pilot operated 45-degree swing design. Lift type or spring-operated types will not be allowed.
- C. Operating floats shall be tied to vertical float rod and shall not swing free in basin.
- D. Provide pump power cords of sufficient length to exit basin and connect to power source above floor outside of basin area.
- E. Mount control panel and alarm panel, on walls secured tightly and permanently.
- F. Basins: Install sump pump basins in indicated locations and connect to sewer lines. Brace interior of basin in accordance with manufacturer's instructions, to prevent distortion or collapse during concrete placement. Refer to Division 03 for concrete work; not work of this section. Set cover over basin, fasten to top flange of basin. Install so cover is flush with finished floor.
- G. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

3.25 ADJUSTING AND CLEANING OF PUMPS

- A. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer.
- B. Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.

3.26 INSTALLATION OF WATER HEATERS

- A. General: Install water heaters in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Provide heat traps per Code on all water heaters.
- B. Support: Place units on concrete pads, orient so controls and devices needing service and maintenance have adequate access.
 - 1. Flue: Connect flue to draft hood with gas-tight connection. Provide flue of minimum size as flue outlet on heater. Comply with gas utility requirements.
- C. Electric Water Heaters:
 - 1. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed

with water heater start-up until wiring installation is acceptable to water heater
Installer.

3.27 EXPANSION TANK

- A. Install expansion tank in accordance with manufacturer's recommendations.
- B. Provide unions and ball valves for complete isolation of the tank from the system.
- C. Charge tank with proper air charge as recommended by manufacturer.
- D. Tank tapings shall be provided as detailed or appropriate, ASME welded tank flanges or nipples.
- E. Suspend tank from building structure.

END SECTION

230500
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 DESCRIPTION OF SYSTEMS

- A. Division 23 includes but is not limited to:
 - 1. Section 23 0500 – Common Work Results for HVAC.
 - 2. Section 23 0548 – Seismic – Vibration Control.
 - 3. Section 23 0553 – HVAC Identification.
 - 4. Section 23 0593 – Testing, Adjusting and Balancing.
 - 5. Section 23 0700 – HVAC Insulation.
 - 6. Section 23 0800 – Commissioning of HVAC Systems
 - 7. Section 23 0923 – Temperature Control Systems – DDC.
 - 8. Section 23 0993 – Sequences of Operations.
 - 9. Section 23 2300 – Refrigerant Piping Systems
 - 10. Section 23 3000 – Air Distribution.
 - 11. Section 23 7302 – Packaged Rooftop Air Handling Units.
 - 12. Section 23 8100 – Electric Heating Terminals.

1.02 DESCRIPTION OF WORK

- A. Work Included: Unless specified otherwise, provide all supervision, labor, materials, transportation, equipment, hauling, and services necessary for a complete and operational HVAC system. Provide all incidental items such as offsets, fittings, etc. required as part of the work even though not specifically shown on Contract Drawings or Specifications.
- B. Requests for Information: See Section 01 2000 – Price and Payment Procedures – Modification Procedures, for required research of Contract Documents and subsequent documentation of noted issues through requests for information.
- C. Types of mechanical related work specified in this section include the following:
 - 1. Motors.
 - 2. Starters.
 - 3. Access Doors.
 - 4. Temporary Heating and Ventilation.
 - 5. Cutting and Patching

1.03 SUBMITTALS

- A. Provide the following submittals:
 - 1. Motors
 - 2. Starters
 - 3. Access Doors.

1.04 REFERENCES

- A. See Section 01 4000 - Quality Requirements - References and Standards, for references to documents and standards.
- B. For products or workmanship specified by Association, Trade or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

- C. The date of the standard is that which is in effect as of the date of the Contract Documents, except when a specific date is specified.

1.05 QUALITY CONTROL

- A. See Section 01 4000 – Quality Requirements, for quality control requirements.
- B. Materials and apparatus required for the HVAC scope of work shall be new and of first-class quality. Erected, connected and finished in every detail, and selected and arranged so as to fit properly into the building spaces.
- C. Unless otherwise specifically indicated, equipment and materials shall be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

1.06 EXAMINATION OF CONTRACT DRAWINGS AND SPECIFICATIONS

- A. The HVAC Drawings show the general arrangement of piping, ductwork, HVAC equipment, and appurtenances, and shall be followed as closely as actual building construction and the work of other trades will permit.
- B. The Architectural and Structural Drawings shall be considered part of the HVAC work insofar as these Drawings furnish this Division with information relating to design and construction of the building.
- C. Field verify building dimensions governing HVAC work. Do not scale the HVAC Drawings for dimensions.
- D. The HVAC Contractor shall request of the Test and Balance (TAB) Contractor an early review of the Contract Documents for the purpose of identifying where proper balancing cannot be achieved. The report requirements are specified in Division 23, Section 23 0593, Testing, Adjusting and Balancing, “Submittals.” Forward a copy of the report to the HVAC engineer for review. The HVAC Contractor shall modify the system as recommended by the TAB Contractor or refer unresolved issues to the HVAC Engineer for resolution prior to ordering of ductwork and equipment. Unresolved balancing issues from untimely or incomplete application of these requirements shall be corrected in the field at no extra cost to the project.
- E. Discrepancies:
 - 1. Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the drawings for the work of this Division and the plans for the work of others. Report such discrepancies as a request for information following the procedure outlined in Section 01 2000.
 - 2. Should there be a conflict in dimensions or locations between the HVAC Drawings and/or Architectural/Structural Drawings, report such discrepancies as a request for information following the procedure outlined in Section 01 2000.

1.07 REGULATORY REQUIREMENTS

- A. See Section 01 4100 – Regulatory Requirements, for applicable codes and regulations in addition to the following.
 - 1. 2022 California Building Code.
 - 2. 2022 California Mechanical Code.
 - 3. 2022 Title 24.
 - 4. 2022 California Fire Code.
 - 5. 2022 California Green Code.

- B. Where hourly fire and smoke ratings are indicated or required, whether or not shown, provide components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

1.08 COORDINATION

- A. See Section 01 3114 – Facility Services Coordination, for coordination requirements and procedures between all applicable construction trades.
- B. Before purchase, fabrication, or installation of HVAC components, determine if the installation will properly fit and can be installed as contemplated without interference with structural elements or the work of other trades.
- C. Locations of pipes, ducts, switches, panels, equipment, and fixtures, shall be adjusted to accommodate the work or interferences anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.
- D. Right of Way: Lines which pitch shall have the right-of-way over those which do not pitch. Lines whose elevations cannot be changed shall have right-of-way over lines whose elevations can be changed.
- E. Offsets, transitions and changes in direction of pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the Drawings.
- F. Where major conflicts occur, contractor shall rely upon the Architect/Engineer to make final decision regarding priority of right-of-way. Prior to installation or removal of components in conflict, report any such conflicts as a request for information following the procedure outlined in Section 01 2000.
- G. When directed by the Architect/Engineer, submit Coordination Drawings showing interrelationship of various portions of work and work of other trades. Failure to properly coordinate may result in removal and relocation at expense to the Contractor.
- H. Three-Dimensional Coordination Documents for Acoustical and Drywall Ceilings, Plumbing, Fire Protection, HVAC and Electrical, shall be provided in accordance with requirements listed in Section 01 3114 – Facility Services Coordination.
- I. Coordination Drawings for Acoustical and Drywall Ceilings, Plumbing, Fire Protection, HVAC and Electrical:
 - 1. Coordination Drawings are required for the trades noted above. The HVAC contractor shall prepare reproducible Coordination Layout and Installation Drawings (at least 1/4" scale or as approved by the Architect) for resolution of interferences and conflicts with other trades.
 - 2. The Plumbing, Fire Protection and Electrical Contractors, as well as acoustical and drywall ceiling contractors, are required to superimpose their Shop Drawings on the HVAC Drawings and verify layout and elevations to eliminate conflicts. Any conflicts shall be highlighted and these Drawings shall be forwarded to the Architect for resolution. Priority shall be given to "gravity" systems above the ceiling. Each trade shall initial acknowledgement that the proceeding has been completed. No fabrication of ductwork, fire protection, or other prefabricated systems shall begin until these Coordination Drawings have been completed and reviewed by the General Contractor and Architect/Engineers. Any Subcontractor that fabricates and installs items above the ceiling before the Coordinated Drawings are reviewed and conflicts resolved shall do so at their own risk, and be responsible to relocate said equipment in the event conflicts arise, at no cost to the Owner.

3. Additionally, all trades shall show the proposed location of access panels (for maintenance) in “hard” ceilings for access to HVAC boxes, control valves, fire damper motors, plumbing valves, fire protection drains, valves, light fixture remote ballasts, ceiling hung equipment, etc., for coordination with the reflected ceiling plans. Indicate on same Drawings the location of access panels in walls as well as location of plumbing cleanouts.
- J. Upon Architect/Engineer completion of the review of the Coordination Drawings, the Design Team, General Contractor and Subcontractors shall conduct a pre-installation coordination meeting for all “fit-up” above ceilings. No ceiling shall be lowered without the expressed approval of the Owner and the Architect
- K. Coordinate all cutting & patching, provide cutting and patching per Section 01 7000.
- L. Utility Interruptions: Coordinate HVAC utility interruptions per Section 01 7000.

1.09 COMMISSIONING

- A. Division 23 is responsible to participate in the commissioning process. See Section 01 9113 - General Commissioning Requirements, Section 23 0800 - Commissioning and Section 23 0995 - Metering, Trending and Remote Data Acquisition for M&V, for commissioning requirements. The commissioning process and contractor responsibilities are described in these sections. HVAC contractor, sub-contractors and manufacturers equipment start-ups to comply with these sections and provide coordination with the commissioning agent as required.

1.10 PROJECT CONDITIONS

- A. Indoor Air Quality During Construction: Contractor is responsible to meet the SMACNA IAQ Guideline for Occupied Buildings Under Construction, 2007, ANSI/SMACNA 008-2008, Chapter 3 and the requirements in Division 1, Section 01 0150 “LEED Requirements.”
- B. Accessibility:
 1. Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of work. Such spaces and clearances shall be kept to the minimum size required.
 2. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect prior to making the change.
 3. Determine the exact locations of access doors. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.
 4. Demonstration of access will be required prior to project completion. The contractor is responsible for providing reasonable and safe access for all system components. HVAC Contractor to demonstrate access and serviceability of all equipment to Owner.
- C. Fabrication: Before any ductwork is fabricated and before installing and/or fabricating any lines of piping or ductwork the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.
- D. Freeze Protection: Do not run pipes in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

- E. Scaffolding, Rigging and Hoisting: Provide scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.11 SUBMITTALS:

- A. See Section 01 3000 – Administration Requirements, for submittal procedures.
- B. The review comments of the Architect and/or Engineer do not in any case supersede the Drawings and Specifications, and shall not relieve the Contractor from responsibility for deviations from the Drawings or Specifications unless the Contractor has called to the attention of the Architect and/or Engineer, in writing, such deviations at the time of submission, nor shall it relieve the Contractor from responsibility for errors of any sort in the items submitted.
- C. Deviations: It is the contractor’s responsibility to indicate deviations from the Plans and Specifications. Approval shall not be considered acceptance of the deviation unless it has been explicitly indicated.

1.12 SEISMIC RESTRAINT PLAN SUBMITTAL:

- A. The contractor shall provide a vibration and seismic restraint plan for projects designated a Seismic Design Category C (with a seismic importance factor greater than 1.0), D, E, or F as found on the structural drawings. The plan shall include stamped and signed (engineer with minimum of 5 years of experience) drawings for the state in which the project is located, details, equipment cutsheets, and analysis from one of the acceptable equipment manufacturers listed below for the entire project scope. The contractor will provide the selected equipment manufacturer with a copy of the drawings, specifications, soils reports and any other pertinent information necessary to perform the vibration and seismic restraint analysis per pertinent codes.
- B. Acceptable Manufacturers:
 1. Mason Industries, Inc.
 2. Kinetics Noise Control, Inc.
 3. M. W. Sausse & Co., Inc.
 4. Amber/ Booth, a VMC Company
 5. Vibro Acoustics

1.13 FIELD REPORTS

- A. During the construction period the Engineer may issue periodic field reports. The contractor shall immediately address the issues and provide a written response.
- B. The written response must be returned to the Architect no later than (5) working days after receipt of the site observation report.

1.14 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Substitutions: See Section 01 6000 – Product Requirements, for substitution procedures applicable to all products specified in Division 23.
- B. Substitution requirements listed in Section 01 6000 apply to any “acceptable manufacturer” that is not the basis of design. Manufacturers specifically shown on the equipment schedules shall be considered the basis of design; the basis of design for unscheduled equipment shall be as noted in the associated specification section.

- C. When alternate or substitute materials and equipment are used, Contractor will be responsible for space requirement, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Contractor shall provide drawings for alternate/substitute equipment in detail equal to the construction documents.

1.15 PROJECT RECORD DOCUMENTS

- A. See Section 01 7800 – Closeout Submittals, for submittal requirements and procedures.

1.16 ELECTRIC WIRING AND SAFETY DEVICE WORK AND MATERIAL RESPONSIBILITIES

- A. Unless otherwise indicated, all HVAC equipment motors and controls shall be furnished, set in place, and wired in accordance with the following schedule: MD = HVAC Division, ED = Electrical Division, TD = Temperature Control Division, I = Installer of equipment requiring electrical service.
- B. Note: If Temperature Control Division is a subcontract to the HVAC Contractor, both MD and TD shall fall under the responsibility of MD. If no Temperature Control Contractor is under contract, MD shall assume all Temperature Control responsibilities.

	Furnished Under	Set in Place or Mounted Under	Power Wired & Connected Under	Control Wired & Connected Under
1. Other Equipment Motors/Starters	I	I	ED	I
2. HVAC Equipment Motors	MD	MD	ED	TD
3. HVAC Magnetic Motor Starters, VFD's	MD	MD	ED	TD
4. Control Wiring Regardless of Voltage	TD	TD	TD See footnote 1	TD
5. Control Components: Control Relays, Thermostats, Control Transformers, EP, PE Switches	TD	TD	TD See footnote 1	TD
6. Temperature Control Panels, Time Clocks, Controllers	TD	TD	TD See footnote 1	TD
7. Valve and Damper Motors and Actuators	TD	TD	TD See footnote 1	TD
8. Control Valves, Solenoid Valves	TD	MD	--	TD
9. Control Dampers Integral with a Fan Unit	MD	MD	--	--
10. Control Dampers (duct mounted)	TD	MD	--	TD
11. Thermowells in Piping	TD	MD	--	--
12. Smoke Duct Detectors (including relays)	ED See footnote 3	MD See footnote 3	ED See footnote 4	ED See footnote 3
13. Fire and Smoke Dampers	MD	MD	ED	ED See footnote 2
14. Pushbutton Stations and Pilot Lights	MD	MD	ED	TD See footnote 4
15. Manual Operating Switches	MD	MD	ED	-- See footnote 5
16. Multi-speed Switches (not integral with Equipment served)	MD	MD	ED	-- See footnote 5
17. Fused and Unfused Disconnect Switches & Thermal Overload Switches	ED See footnote 6	ED See footnote 6	ED	--

	Furnished Under	Set in Place or Mounted Under	Power Wired & Connected Under	Control Wired & Connected Under
18. Contactors	ED	ED	ED	ED
19. Temporary Heating Connection	MD	MD	ED	TD
20. Boiler Controls, Boiler Burner Control Panels Internally Wired	MD	MD	TD See footnote 1	TD
21. Remote Disconnect Switches for Boiler (Domestic HW & Pool Heat) Controls per ASME-CSD-1.	TD	TD See footnote 7	TD See footnote 8	TD

1. Footnote 1: It is the intention of this specification for all conduit and wiring which connects to control equipment or provides controls to HVAC equipment to be provided by the Temperature Control Contractor. Other portions of the specification which may be in conflict with this concept shall be brought to the attention of the engineer for clarification prior to bidding the project. The ED shall provide line voltage wiring conduit and junction boxes for the express purpose of temperature controls. It shall be the responsibility of the Temperature Control Contractor to coordinate the location of the junction boxes (if not otherwise shown on the Electrical Drawings) and to utilize these junction boxes for temperature control wiring. The Temperature Control Contractor shall extend line and/or low voltage wiring from junction boxes to all HVAC and control components which require control wiring.
 2. Footnote 2: Wiring from the fire alarm electrical contacts to fire alarm system control panel by ED; all HVAC equipment control function wiring by TD. ED to coordinate locations of electrical contact with MD. MD to coordinate locations of duct smoke detectors with ED.
 3. Footnote 3: MD shall assist in locating the detectors, but ED shall verify that the installation meets the manufacturer's installation guidelines, and is responsible for correctly ordering the smoke detectors. MD shall mount the detectors in a manner directed by ED according to manufacturer's recommendation. If the detector is used for operation of a smoke/fire damper, the control wiring will be by ED. If the unit is used for fan shutdown, the fire alarm functions will be by ED and the wiring to the starter or VFD for a direct shutdown will be by MD, typically by the TD. Any signal required for the sequence of operation shall be coordinated between MD and ED, with ED providing a point of connection and MD responsible for the remainder of the installation.
 4. Footnote 4: For connection to auxiliary contacts if required.
 5. Footnote 5: Device is used in the power wiring circuit to the equipment. Control functions do not exist.
 6. Footnote 6: Unless furnished with equipment.
 7. Footnote 7: A manually operated remote shutdown switch(es) shall be located just outside the boiler room door and marked for easy identification. Consideration should be given to the type and location of the switch to safeguard against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door. The emergency shutdown switch shall be wired to the boiler safety circuit relay and shall disconnect all power to the boiler safety circuit.
 8. Footnote 8: TD shall provide 24V to emergency power off switches.
- C. Provide Division 26 with a complete summary list of all HVAC equipment requiring electric power prior to within 30 days after award of contract. This list shall summarize equipment power loads, line voltage control requirements, quantities, and locations of equipment and connection points. If any HVAC equipment is required to run on emergency power, the list shall note that requirement along with the requirement for the building temperature controls systems to also be on emergency power.

1.17 DELIVERY, STORAGE AND HANDLING

- A. See Section 01 6000 – Product Requirements, for delivery, storage and handling requirements.

1.18 WARRANTIES

- A. See Section 01 7800 – Closeout Submittals, for general warranty requirements.

1.19 SCHEDULE OF TESTING

- A. See Section 01 4533 – Code Required Special Inspections, for testing requirements and procedures.
- B. Make all specified tests on piping, ductwork and related systems as necessary. Demonstrate the proper operation of equipment installed under this project.
- C. Equipment shall not be tested, or operated for any purpose until fully lubricated in accordance with manufacturer's instructions and until connections to fully operative systems have been accomplished.
- D. A schedule of testing shall be in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel. All testing must be performed in the presence of the Contractor's representative; his signature for verification of the test must appear on the schedule. At completion of testing, the schedule shall then be submitted in triplicate to the Architect.
- E. Make sure operational and performance tests are made on seasonal equipment.

1.20 KEYS

- A. Keys: Upon completion of work, submit keys for HVAC equipment, panels, etc. to the General Contractor.

1.21 OPERATING AND MAINTENANCE DATA

- A. See Section 01 7800 – Execution and Closeout Requirements, for Operating and maintenance Manual requirements.

1.22 INSTRUCTIONAL SESSIONS

- A. See Section 01 7900 - Demonstration and Training, for all instruction session requirements. Both HVAC Contractor and Temperature Controls Contractor to provide separate training on respective systems per this section.

PART 2 PRODUCTS

2.01 MOTORS

- A. Motor Characteristics: Except where more stringent requirements are indicated, comply with the following requirements for motors of mechanical work:
 1. Temperature Rating: Rated for 104°F (40°C) environment with maximum 122°F (50°C) temperature rise for continuous duty at full load (Class A Insulation).
 2. Altitude Deration: Motors to be furnished to maintain specified rated service factor at altitude of project.

3. Starting Capability: Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than 5 starts per hour for manually controlled motors.
 4. Phases and Current Characteristics: Provide squirrel-cage induction polyphase motors for 3/4 hp and larger. Provide capacitor-start single-phase motors for 1/2 hp and smaller; except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division-26 sections and with individual equipment requirements specified in other Division-23 requirements. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
 5. Power Factor: All motors rated greater than 1000 watts shall have a Power Factor of not less than 85% under rated load conditions. The 85% PF may be obtained by design of the motor or by providing a capacitor. Capacitors, if provided to obtain the 85% PF, must be switched with the motor. If the motor draws less than 1000 watts at full load, it is excluded from the 85% power factor requirement.
 6. Efficiency: Motor efficiency ratings shall conform to NEMA Standard MG-1-2011.
 7. Service Factor: 1.15 for three-phase motors and 1.35 for single-phase motors.
 8. VFD Compatible: All three-phase motors shall be inverter duty for use with a VFD.
- B. Motor Construction: Provide general purpose, continuous duty motors, Design "B" or "C" where required for high starting torque. Provide inverter duty motors, for all variable speed motor applications:
1. Frames: NEMA No. 56.
 2. Bearings: Ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is normally inaccessible for regular maintenance. Provide double shielded ball bearings in accordance with ANSI-B 3.16-1972.
 3. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual sections of Division 23 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
 4. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 23 for other enclosure requirements.
 5. Overload Protection: Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
 6. Noise Rating: Provide "Quiet" rating on motors. Motors shall not exceed 80 DB at full speed and power.
 7. Shaft Grounding Kits: Provide shaft grounding rings for all 3-phase motors with variable frequency drives as called out on the plans.
- C. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
- D. Manufacturer: Except where item of mechanical equipment (which otherwise complies with requirements) must be integrally equipped with motor produced by another manufacturer, provide motors for mechanical equipment manufactured by one of the following:
1. Allis-Chalmers Corp.
 2. Baldor Electric Co.
 3. Century Electric Div., Inc.
 4. General Electric Co.
 5. Louis Allis Div.; Litton Industrial Products, Inc.
 6. Marathon Electric Mfg. Corp.
 7. Reliance Electric Co.
 8. Westinghouse Electric Corp.

2.02 STARTERS

- A. Motor Starter Characteristics: Comply with NEMA standards and NEC. Provide enclosures NEMA Type as required with padlock ears, and with frames and supports for mounting on wall, floor or panel as indicated. Where starter location is not within sight of motor, provide fused disconnect switch within sight of motor. Provide type and size of starter recommended by motor manufacturer and equipment manufacturer for applicable protection and start-up condition; refer to individual equipment sections for basic load requirements.
1. Manual Switches: Provide manual switch and pilot light for motors 1/2 hp and smaller, except where interlock or automatic operation is indicated. Provide extra switch positions and pilot lights for multi-speed motors.
 - a. Overload Protection: Provide melting alloy type thermal overload relays.
 2. Magnetic Starters: Provide magnetic starters for motors 3/4 hp and larger, and for smaller motors where interlock or automatic operation is indicated. Include the following:
 - a. Heavy-duty oiltight type hand-off-auto switch and pilot lights, properly arranged for single-speed operation as indicated.
 - b. Trip-free thermal overload relays, each phase.
 - c. Built-in 120-volt control circuit transformer, fused from line side and on secondary side.
 - d. Control circuit conductors to be protected in accordance with Article 250-5, Exception 5, of the National Electric Code.
 - e. Externally operated manual reset.
 - f. Undervoltage release or protection.
 - g. Hand-off-auto switch.
 - h. Single Phasing Protection: All starters shall include a phase protection relay mounted and wired in the starter enclosure, equal to time-mark 257 series or motor saver model 201. Starters for motors 5 hp and less may meet this requirement either by supplying the phase protection relay as above, or by providing a current differential trip mechanism in the overload relay which advances the trip setting 25% or more under single phase conditions. Submittals must include documentation of the type of single phasing protection is used.
 - i. Provide spare normally open and normally closed contacts.
 - j. With two speed starters, include an adjustable time delay device within starter enclosure to allow the motor to come to a complete stop when switching from high to low speed. Two speed starters shall have heavy duty 4 position rotary switch, "auto-off-low-high".
- B. Weather Protection: Provide weather-proof mounting of magnetic starters for equipment outside of the building.
- C. Unless furnished otherwise, provide over current protection for each motor. Coordinate with Division 26.
- D. Motor Starter Manufacturer: Provide motor starters for mechanical equipment manufactured by one of the following:
1. ABB.
 2. Allen-Bradley Co.
 3. Cutler-Hammer, Inc.
 4. General Electric Co.
 5. Sprecher & Schuh.
 6. Square D Co.
 7. Westinghouse Electric Co.

2.03 ACCESS DOORS

- A. See Section 08 3100 – Access Doors and Panels, for access door product requirements.

PART 3 EXECUTION

3.01 INSTALLATION OF MOTORS AND STARTERS

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Install starters and wiring devices securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate for proper operational access, including visibility, and for safety.
- C. Install control connections for motors to comply with NEC and applicable provisions of Division 26 sections.

3.02 ACCESS TO MECHANICAL WORK

- A. Installation:
 - 1. Provide access doors for installation and provide instructions for their location. Exact location of access doors to be as directed by HVAC Contractor and Architect/Engineer.
 - 2. Furnish all access doors whether shown or not.
 - 3. Comply with manufacturer's instructions for installation of access doors.
 - 4. Coordinate installation with work of other trades.
 - 5. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.
 - 6. Access door location shall be coordinated with Architect/Engineer prior to installation. All access panels not coordinated will run the risk of removal and relocation at the expense of the contractor.
 - 7. Install access doors for the following concealed equipment:
 - a. Manual volume dampers.
 - b. Valves.
 - c. Control devices.
 - d. Fire dampers and fire/smoke dampers.
 - e. Coils.
 - f. Other mechanical equipment requiring service.
- B. Adjust and Clean:
 - 1. Adjust hardware and panels after installation for proper operation.
 - 2. Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

3.03 CUTTING AND PATCHING

- A. See Section 01 7000 – Cutting and Patching, for all general cutting and patching requirements.

3.04 HEATING AND COOLING SYSTEMS USED FOR TEMPORARY CONDITIONING DURING CONSTRUCTION

- A. Permanent heating and cooling systems shall not be used unless approved in writing.
- B. If for any reason a mechanical system has been placed into operation, it shall not be shut down except for moderate weather, and all heated areas shall be maintained at a minimum temperature of 50°F, 24 hours a day. Building must be totally enclosed; no temporary barriers.

- C. When any air-handling equipment is used for temporary conditioning, the filters shall be installed and maintained. Filter efficiency shall have minimum rating of MERV-8.
- D. Before building acceptance by Owner, these units shall be thoroughly cleaned and new filters shall be installed. This is over and above the set of filters to be provided the Owner as called for in the specifications. Coils shall be cleaned if necessary, as determined by the Architect or Engineer:
 - 1. Any and all systems being used for temporary conditioning shall become the contractor's responsibility to maintain, and be put into first class working order before acceptance by the Owner.
 - 2. Any guarantees that start with the use of equipment for temporary conditioning shall be personally extended by the contracting firm holding the prime contract for construction, so that the Owner will have fully specified warranty from date of acceptance.

END SECTION

230548
SEISMIC VIBRATION CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

A. Seismic Restraint Plan

1. The contractor shall provide a vibration and seismic restraint plan for projects designated a Seismic Design Category 'D' as found on the structural drawings. The plan shall include stamped and signed drawings for the state in which the project is located, details, equipment cutsheets, and analysis from one of the acceptable equipment manufacturers listed below for the entire project scope. The contractor will provide the selected equipment manufacturer with a copy of the drawings, specifications, soils reports and any other pertinent information necessary to perform the vibration and seismic restraint analysis per pertinent codes.
2. DIV 21 fire protection equipment and piping contained within this project are required for a life-safety function, therefore the component importance factor used for the DIV 21 restraint plan shall = 1.5
3. DIV 22 plumbing equipment and piping contained within this project that are required for a life-safety function or components containing hazardous/flammable materials shall be designed for a component importance factor of 1.5. All other equipment and piping shall be designed for a component importance factor of 1.0.
4. The DIV 23 mechanical equipment, piping and ductwork contained within this project that are required for a life-safety function or components containing hazardous/flammable materials shall be designed for a component importance factor of 1.5. All other equipment and piping shall be designed for a component importance factor of 1.0.
5. Acceptable Manufacturers:
 - a. Mason Industries, Inc.
 - b. Kinetics Noise Control, Inc.
 - c. M. W. Sausse & Co., Inc.
 - d. Amber/ Booth, a VMC Company
 - e. Vibro Acoustics

B. Intent

1. Mechanical equipment, piping and ductwork shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
3. All non-exempt systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.
4. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).
5. Seismic restraints where required shall be designed in accordance with seismic force levels as detailed in section 1.0.6.

C. Work in this section includes but is not limited to the following.

1. Vibration isolation for piping, ductwork and equipment.
2. Equipment isolation bases.
3. Flexible piping connections.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.

6. Certification of seismic restraint designs and installation supervision.
7. Certification of seismic attachment of housekeeping pads.
8. Seismic restraint requirements shall be met for all non-exempt mechanical, plumbing and fire protection systems. Equipment buried underground is excluded but entry of services through the foundation wall is included. Refer to the below equipment schedule for list of mechanical systems associated importance factor and exclusions.

MECHANICAL COMPONENT SEISMIC SCHEDULE			
COMPONENT	DIVISION	COMPONENT IMPORTANCE FACTOR	SEISMIC RESTRAINTS REQUIRED OR EXCLUDED
Plumbing Water, Waste and Vent Piping Systems Greater Than 1" Diameter	22	1.0	Required (Note: 2)
Plumbing Water, Waste and Vent Piping Systems Less Than or Equal to 1" Diameter	22	1.0	Excluded (Note: 2)
Plumbing Water, Waste and Vent Piping Systems Supported by Trapeze Hangers where total weight is less than 10 lb/ft	22	1.0	Excluded (Note: 2)
Plumbing Equipment Unless Otherwise Noted	22	1.0	Excluded
Ductwork With Crosssectional Area Greater Than 6.0 square feet	23	1.5	Required
Ductwork With Crosssectional Area Less Than or Equal to 6.0 square feet	23	1.0	Excluded
Fire Dampers	23	1.5	Required
Fire/Smoke Dampers	23	1.5	Required
Fan Coil Units	23	1.0	Required (Note: 3)
Suspended Unit Heaters and Cabinet Unit Heaters	23	1.0	Required
Air Devices	23	1.0	Excluded
Rooftop Units	23	1.0	Required (Note: 4)
Roof Mounted Exhaust Fans	23	1.0	Required (Note: 5)
Note 1: Fire Protection System is inclusive of all components within the Division 21 specifications.			
Note 2: Limits for piping systems assume individual clevis hanger type mountings. Trapeze mountings for piping with a combined operating weight over 10lb/ft shall not be allowed.			
Note 3: Fan coil units that are mounted more than 4-feet above the floor and weighing 75 lbs or more per ASCE 7-10. Provide seismic attachments as required by ASCE 7-10. Verify requirement with local jurisdiction.			
Note 4: Provide seismic curbs and/or attachments as required by ASCE 7-10.			
Note 5: Only required for fans over 400 lbs per ASCE 7-10.			

D. Definitions

1. Life Safety Systems: All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and fire/smoke dampers.
2. Positive Attachment: A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided AC@ type beam clamps for support rods of overhead piping, ductwork, fire protection, or any other equipment are not acceptable on this project as seismic attachment points
3. Transverse Bracing: Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

4. Longitudinal Bracing: Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

1.02 SUBMITTAL REQUIREMENTS

- A. The manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:
- B. Descriptive Data:
 1. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
 2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
- C. Shop Drawings:
 1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 2. Provide all details of suspension and support for ceiling suspended equipment.
 3. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers= submittals must include spacing, static loads and seismic loads at all attachment and support points.
 4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
 5. All drawings and calculations shall be reviewed and accepted by the building department, or authority having jurisdiction prior to submitting to the Architect. Indication of review and acceptance by all agencies, as appropriate, shall be certified by name of reviewer, agency, and date affixed to the plans or reproducible submitted to the Architect
- D. Seismic Certification and Analysis:
 1. Seismic restraint calculations must be provided for all connections of equipment to the structure requiring seismic supports as identified in the seismic restraint plan. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
 2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45E to the weakest mode.
 3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.06 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.03 CODES AND STANDARDS REQUIREMENTS

- A. Applicable Codes and Standards
 1. 2022 California Building Code
 2. ASCE 7 10

1.04 MANUFACTURER'S RESPONSIBILITY

- A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:
 - 1. Determine vibration isolation and seismic restraint sizes and locations.
 - 2. Provide vibration isolation and seismic restraints as scheduled or specified.
 - 3. Provide calculations and materials as required for restraint of un-isolated equipment.
 - 4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.05 RELATED WORK

- A. Housekeeping Pads
 - 1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
 - 2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.
- B. Supplementary Support Steel: Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified
- C. Attachments: Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor=s calculations

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS AND SEISMIC RESTRAINTS

- A. Intent
 - 1. All vibration isolators and seismic restraints described in this section shall be the product of a single manufacturer. Mason Industries products are the basis of these specifications, products of other manufacturers are acceptable provided their systems strictly comply with the specification and have the approval of the specifying engineer. Submittals and certification sheets shall be in accordance with section 1.02.
 - 2. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater than 1/4" (6mm).
- B. Two layers of 3/4" (19mm) thick neoprene pad consisting of 2" (50mm) square waffle modules separated horizontally by a 16 (1.5mm) gauge galvanized shim. Load distribution plates shall be used as required.
- C. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Preapproval @OPA@ Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.

- D. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality.
- E. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.
- F. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6mm) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
- G. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Restraining Bolts shall have a neoprene bushing between the bolt and the housing. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval AOPA@ Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings.
- H. Spring mountings as in specification 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4" (6mm) travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Preapproval AOPA@ number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
- I. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8" (3mm). Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.
- J. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation.
- K. Hangers shall consist of rigid steel frames containing minimum 1 1/4" (32mm) thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall

have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30E arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30E capability.

1. Hangers shall be as described in 10, but they shall be supplied with a combination rubber and steel rebound washer as the seismic upstop for suspended piping, ductwork, equipment and electrical cabletrays. Rubber thickness shall be a minimum of 1/4" (6mm). Submittals shall include a drawing of the hanger showing the installation of the rebound washer.
- L. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30E capability.
- M. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be prestretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval AOPA@ Number from OSHPD in the State of California verifying the maximum certified load ratings.
- N. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval AOPA@ number from OSHPD in the state of California verifying the maximum certified load ratings.
- O. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval AOPA@ Number from OSHPD in the State of California.
 1. Note: Specifications M - O apply to trapeze as well as clevis hanger locations. At trapeze locations piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.
- P. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval AOPA@ Number from OSHPD in the State of California.
- Q. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" (6mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm²). A minimum air gap of 1/8" (3mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Preapproval AOPA@ Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.

- R. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" (19mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm²). Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" (3mm) nor more than 1/4" (6mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (9mm) deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable ΔG force. Submittals shall include the load deflection curves up to 1/2" (12mm) deflection in the x, y and z planes. Snubbers shall have an anchorage preapproval ΔOPA number from OSHPD in the state of California verifying the maximum certified horizontal and vertical load ratings.
- S. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is rolled up to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads.
- T. Male wedge screw anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O. Evaluation Service, Inc. verifying to its allowable loads
- U. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" (350mm) provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1" (25mm).
- V. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6" (150mm). The base depth need not exceed 12" (300mm) unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" (12mm) bars welded in place on 6" (150mm) centers running both ways in a layer 1 2" (38mm) above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" (25mm) clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.
- W. Curb mounted rooftop equipment shall be seismically restrained as specified in the Seismic Restrain Plan of this specification. The contractor shall provide all design, engineering, and stamped drawings for all seismic curb and mechanical equipment restraint as well as all support structure required.
- X. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar⁷ tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" (50mm) and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16"(400mm) to 24" (600mm) may be

single sphere. Sizes :@ (19mm) to 12@ (38mm) may have threaded two piece bolted flange assemblies, one sphere and cable retention. Connectors shall be rated at 250 psi (1.72MPa) up to 170EF (77EC) with a uniform drop in allowable pressure to 215 psi (1.48MPa) at 250EF (121EC) in sizes through 14" (350mm). 16" (400mm) through 24" (600mm) single sphere minimum ratings are 180 psi (1.24MPa) at 170EF (77EC) and 150 psi (1.03MPa) at 250EF (121EC). Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.

1. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods. If control rods are used, they must have 2@ (12mm) thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi (.7 kg/mm²) maximum on the washer area.
 2. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves.
- Y. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" (75mm) and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:
1. Flanged
 - a. 3" x 12" (75 x 300mm)
 - b. 6" x 18" (150 x 450mm)
 - c. 12" x 24" (300 x 600mm)
 - d. 4" x 12" (100 x 300mm)
 - e. 8" x 18" (200 x 450mm)
 - f. 14" x 30" (350 x 750mm)
 - g. 5" x 18" (125 x 450mm)
 - h. 10" x 18" (250 x 450mm)
 - i. 16" x 32" (400 x 800mm)
 2. Male Nipples
 - a. 1/2" x 12" (12 x 300mm)
 - b. 1-1/4" x 12" (32 x 300mm)
 - c. 2" x 12" (50 x 300mm)
 - d. 3/4" x 12" (19 x 300mm)
 - e. 1-1/2" x 12" (38 x 300mm)
 - f. 2-1/2" x 18" (64 x 450mm)
 - g. 1" x 12" (25 x 300mm)
 3. At equipment, hoses shall be installed on the equipment side of the shut off valves horizontal and parallel to the equipment shafts wherever possible. Hoses shall be type FFL or type MN as manufactured by Mason Industries, Inc.
- Z. Flexible hose expansion loops shall have stainless steel braid and carbon steel, flanged fittings. Expansion loops for plumbing shall be lead free. Expansion loops shall be manufactured complete with two parallel section of corrugated metal hose, braid, 180° return bend, with flanged inlet and outlet connections.
- AA. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (.35 kg/mm²) and the design shall be balanced for equal resistance in any direction.

- BB. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (12mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of ∇ 1 5/8" (41mm) motion, or to meet location requirements.
- CC. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" (19mm) thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" (25mm) past either face of the wall. Where temperatures exceed 240EF(115EC), 10# (4.5kg) density fiberglass may be used in lieu of the sponge.
- DD. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit.
- EE. Housekeeping pad anchors shall consist of a ductile iron casting that is tapered and hexagonal, smaller at its base than at its top. The upper portion shall have holes for rebar to pass through. The anchor shall be continuously threaded from top to bottom for the attachment of soleplates. Housekeeping pad anchors shall be attached to the structural slab using a stud wedge anchor. Housekeeping pad anchors shall be type.
- FF. Isolation Hangers: Hanger units formed with brackets and including manufacturer's standard compression isolators of type indicated. Design brackets for 3 times the rated loading of units. Fabricate units to accept misalignment of 15 degrees off center in any direction before contacting hanger box, and for use with either rod or strap type members, and including acoustical washers to prevent metal-to-metal contacts.
1. Provide vibration isolation spring with cap in lower part of hanger and rubber hanger element in top, securely retained in unit.
 2. Provide hangers, precompressed to rated load to limit deflection during installation.
 3. Provide 1/2" minimum deflection.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.02 APPLICATIONS

- A. General: Except as otherwise indicated, select vibration control products in accordance with the latest edition of the ASHRAE Handbook, "Sound and Vibration Control". Where more than one type of product is offered, selection is Installer's option.

3.03 GENERAL

- A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.
- C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. ABuilding@ includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Coordinate work with other trades to avoid rigid contact with the building.
- F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.
- G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.
- H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractors expense.
- I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
 - 1. Flanges of structural beams.
 - 2. Upper truss cords in bar joist construction.
 - 3. Cast in place inserts or wedge type drill-in concrete anchors.
- J. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- K. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.
- L. At locations where specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with specification 14 braces.
- M. At locations where specification 12 cable restraints are installed on support rods with spring isolators, the spring isolation hangers must be specification type 10A.
- N. At all locations where specification 12 or 13 restraints are attached to pipe clevis, the clevis cross bolt must be reinforced with specification type 15 braces.
- O. Drill-in concrete anchors for ceiling and wall installation shall be specification type 18, and specification type 19 screw type for floor mounted equipment.

- P. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.
- Q. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed specification 23 capabilities.
- R. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 27 wall seals.
- S. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be specification type 28.
- T. Locate isolation hangers as near to the overhead support structure as possible.
- U. All fire protection piping shall be braced in accordance with NFPA 13 and 14.
- V. All mechanical equipment shall be vibration isolated and seismically restrained as per the schedules in part 4 of this specification.
- W. All fire protection equipment is considered life safety equipment and shall be seismically restrained using the seismic force levels for life safety equipment.
- X. VAV boxes and fan powered equipment weighing less than 75 lbs. (23kg) and rigidly connected to the supply side of the duct system and supported with a minimum of 4 hanger rods.

3.04 VIBRATION ISOLATION OF PIPING

- A. Horizontal pipe isolation: The first four pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. For seismic restraint locations, brace hanger rods with SRC clamps specification 14. Floor supported piping shall rest on isolators as described in specification 6. Heat exchangers and expansion tanks are considered part of the piping run. The first two isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. Pipe hangers shall have 0.75" (19mm) deflection. Hangers shall be located as close to the overhead structure as practical. Hanger locations that also have seismic restraints attached must have type RW Rebound Washers to limit uplift. Where piping connects to mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.
- B. Seismic Restraint of Piping
 - 1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on un-isolated piping.
 - a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is larger than 1" (25mm).
 - b. All other piping larger than 3".
 - 2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 - 3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 - 4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
 - 5. For fuel oil and all gas piping transverse restraints must be at 20' (6m) maximum and longitudinal restraints at 40' (12m) maximum spacing.

6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" (600mm) of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.
9. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in areas with S_s of 0.35 or greater shall be braced as in sections 3.02.C.2 and 3. For areas with S_s less than 0.35, 2 band clamps may be used with a reduced spacing of 1/2 of those listed in sections 3.02.C.2 and 3.
10. Connection to the structure must be made with a non-friction connection (i.e. no AC@ clamps)
11. Hanger locations that also have seismic restraints attached must have Specification 10A type RW Rebound Washers.

C. Pipe Exclusions

1. All piping suspended by clevis hangers where the distance from the top of the pipe to the suspension point is 12" or less and cannot create a moment connection.
2. All trapezed piping where the distance from the suspension point to the trapeze member is 12" or less and cannot create a moment connection.
3. If any suspension (1) location in the run exceeds the above, the entire run must be braced.

3.05 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF DUCTWORK

A. Vibration isolation of ductwork

1. All discharge runs for a distance of 50' (15m) from the connected equipment shall be isolated from the building structure by means of specification 10 hangers or specification 5 floor isolators. Spring deflection shall be a minimum of 0.75" (19mm).
2. All duct runs having air velocity of 1000 fpm (5 m/s) or more shall be isolated from the building structure by specification 11 hangers or 5 floor supports. Spring deflection shall be a minimum of 0.75" (19mm).

B. Seismic restraint of ductwork

1. Seismically restrain all ductwork with specification 12 or 13 restraints as listed below:
 - a. Restrain rectangular ducts with cross sectional area of 6 sq.ft. (.5 m²) or larger.
 - b. Restrain round ducts with diameters of 28" (700mm) or larger.
 - c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
2. Transverse restraints shall occur at 30' (9m) intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
3. Longitudinal restraints shall occur at 60' (18m) intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' (1.2m) of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
4. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

7. Connection to the structure must be made with a non-friction connection (i.e. no AC@ clamps)
 8. Hanger locations that also have seismic restraints attached must have Specification 10A type RW Rebound Washers.
- C. Ductwork Exclusions
1. Rectangular and square ducts that are less than 6 square feet in cross sectional area.
 2. Oval ducts that are less than 6 square feet (.5m²) in cross sectional area based on nominal size.
 3. Round duct less than 28" (.5m²) in diameter.
 - a. All trapezoid ductwork where the distance from the suspension point to the trapeze member is 12" or less.
 - b. Ductwork hung with straps where the top of the duct is 12" or less from the suspension point and the strap has 2 #10 sheet metal screws within 2" of the top of the duct.
 - c. If any (1) suspension location in the run exceeds the above, the entire run must be braced.

END SECTION

230553
HVAC IDENTIFICATION

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Types of identification devices specified in this section include the following:
 - 1. Engraved Plastic-Laminate Signs.

1.02 SUBMITTALS

- A. Provide the following submittals:
 - 1. Plastic-laminate signs.

1.03 REFERENCES

- A. American National Standards Institute (ANSI)
 - 1. ANSI A13.1 "Scheme for Identification of Piping Systems".
 - 2. ANSI Z53.1 "Safety Color Code for Marking Physical Hazards".
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

PART 2 PRODUCTS

2.01 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.02 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. When more than one HVAC unit is present, it shall be permanently identified as to the area or space served by the equipment. Provide signs for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Meters, gauges, thermometers and similar units.
 - 3. Fans, blowers, primary balancing dampers and mixing boxes.

4. Packaged HVAC central-station, zone-type and rooftop units.
 5. Fan coil units
 6. Dedicated outdoor air units.
 7. Heat recovery and condensing units.
- B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Lettering Size: Minimum 1" high lettering for name of unit.
- D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions and warn of hazards and improper operations.
- E. Ceiling Labels:
1. Fire and Smoke Damper Identification: Access points, i.e. access doors, access panels, lay-in ceiling tile, etc., shall be permanently identified on the exterior of the access point using a ½ inch wide clear label with black lettering reading: "SMOKE DAMPER" or "FIRE DAMPER" or "FIRE/SMOKE DAMPER".
 2. Provide ceiling labels to locate fan coil units, cabinet heaters, exhaust fans, control dampers and other mechanical equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment using ½ inch wide clear label with black lettering.

END SECTION

230593
TESTING ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 RELATED WORK

- A. Extent of testing, adjusting, and balancing work required by this section is indicated by requirements of this section; and is defined to include, but is not necessarily limited to, air distribution systems and associated equipment, and apparatus of mechanical work. The work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to the work as required by the contract documents.
1. Fans.
 2. Ductwork systems, including terminal units.
 3. Rooftop units.
 4. Domestic hot water recirculating pumps & system balancing valves shown on plumbing plans.
 5. Fan coil units.

1.02 COMMISSIONING

- A. The project will have selected building systems commissioned. The equipment and systems to be commissioned are specified in Section 23 0800. The commissioning process and contractor responsibilities are described in Section 23 0800.

1.03 QUALITY ASSURANCE

- A. Contractor's Qualifications: Firm with at least 5-years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.

1.04 QUALIFICATIONS OF CONTRACTOR

- A. The Mechanical Contractor shall procure the services of an independent testing and balancing agency specializing in the testing, adjusting and balancing of environmental systems to perform the above-mentioned work. Testing and balancing report shall be certified by a Registered Professional Engineer, or a NEBB or TABB Certified Balancing Supervisor who is registered and/or certified in the jurisdiction where the testing is being conducted. The Engineer, NEBB, or TABB Supervisor shall represent the balancing firm in progress meetings as required, and shall be available for interpreting all material found in the balance report. Any individual involved in actual testing and balancing shall be under the direct supervision of the Registered Professional Engineer or the NEBB or TABB certified supervisor.
- B. Codes and Standards:
1. NEBB Compliance: Comply with NEBB's latest edition of "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" as applicable to mechanical air distribution systems, and associated equipment and apparatus.
 2. TABB Compliance: Comply with TABB's "Testing, Adjusting and Balancing Bureau Standards, Procedure and Specifications" as applicable to mechanical air distribution systems, and associated equipment and apparatus.
 3. AABC Compliance: Comply with the latest edition of AABC's Manual MN-1 "AABC National Standards", as applicable to mechanical air distribution systems, and associated equipment and apparatus.

1.05 APPROVAL OF CONTRACTOR

- A. Testing, Adjusting and Balancing (TAB) firms acceptable to do the work are:
- B. Any Testing, Adjusting and Balancing (TAB) firm desiring to offer their services for this work shall submit their qualifications to the Engineer, not less than seven (7) calendar days before the bid date. Their submittals shall include the name and Professional Engineer stamp of the engineer who will be supervising the testing and balancing. Copies of each Supervisor's certificate shall be included in the submittals. This submittal of qualifications will be reviewed by the Engineer. The Engineer will then approve or disapprove this TAB firm based on these qualifications.
- C. All TAB work shall comply with the requirements of Division 01 as it relates to Commissioning.

1.06 SUBMITTALS

- A. Submit certified test reports, signed by Test and Balance Supervisor who performed TAB work. In addition, have the report certified by the Professional Engineer who is familiar with the TAB work on this project.
- B. Submit biographical data on Engineer who is to directly supervise testing, adjusting, and balancing work.

1.07 JOB CONDITIONS

- A. Do not proceed with testing, adjusting, and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt, and discarded building materials.
- C. Put all heating, ventilating and air conditioning systems and equipment into full operation and continue operation of same during each working day of testing and balancing. Preliminary TAB requirements shall be ascertained prior to the commencement of work through a review of available plans and specifications for the project. In addition, visual observations at the site during construction shall be made to determine the location of required balancing devices and that they are being installed properly for the need.
- D. Before any air balance work is done, the following will be completed on each system:
 - 1. Check for duct leakage.
 - 2. Assure filters are installed.
 - 3. See that filters are changed if they are dirty.
 - 4. Check for correct fan rotation.
 - 5. Check equipment vibration.
 - 6. Check automatic dampers for proper operation.
 - 7. Place all volume control dampers and outlets wide open at this time.
- E. Before any hydronic balancing work is done, the system shall be checked for plugged strainers, correct pump rotation, correct control valve installation and operation, air locks, check system static pressure to assure system operation is below the limits of the system relief valves, proper flow meter and check valve installation. All throttling devices and control valves shall be open at this time.

1.08 INSPECTION OF THE CONTRACT DOCUMENTS

- A. The Test and Balance contractor shall request from the Division 23 contractor a set of documents so that he can review his ability to balance the mechanical system. If any portion of the system cannot be balanced due to its configuration, a report shall be issued to the Division 23 contractor pointing out those areas where proper balancing will be impossible to achieve. This report shall be issued in time to make corrective actions prior to the purchase of materials.
- B. The TAB contractor shall obtain and review all equipment submittals prior to initiating the air balance work. Where values on the submittals vary from the contract documents, clarification shall be obtained from the engineer.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. Except as otherwise indicated, use the same products as used by the original Installer for patching holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.
 - 1. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2.02 TEST INSTRUMENTS

- A. Utilize test instruments and equipment for TAB work required, of type, precision, calibration and capacity as recommended in the following TAB standards:
 - 1. NEBB's Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 - 2. TABB's Standards, Procedures and Specifications.
 - 3. AABC's Manual MN-1 "AABC National Standards".

PART 3 EXECUTION

3.01 GENERAL

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned, and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester.
- B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.
- C. Test, adjust and balance system during summer season for air conditioning systems and during winter season for heating systems, including at least period of operation at outside conditions within 5°F wet bulb temperature of maximum summer design condition, and within 10°F dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit.
- D. Balance all flows to terminals within +10% to -5% of design flow quantities. Measure and record the data.
- E. Systems may be tested in increments when approved by the Engineer.

- F. When testing and balancing involve the building temperature control systems, coordinate with the temperature control subcontractor to achieve the desired results. All setpoints shall be documented and included with test report.
- G. When deemed necessary by the mechanical consulting Engineer, the Test & Balance firm shall run temperature and/or humidity recordings and shall read any of the air report quantities in the presence of the engineer for verification purposes.
- H. Permanently mark the settings of valves, dampers, and other adjustment devices so that adjustment can be restored if disturbed at any time.
- I. The contractor shall report observations made on the job such as noisy systems and unusual equipment vibration.

3.02 AIR BALANCE

- A. Balance all supply, return and exhaust systems with air quantities for each air device; air handling units including supply, return, mixed, and outside temperatures and fan data including CFM, static pressure, fan RPM, motor running and full load amperage before and after final balance. Air diffusion patterns shall be set to minimize objectionable drafts and noise.
- B. The supply, return and exhaust fan static pressure shall be set by the balancing firm and the control contractor if the systems have fan volume control dampers. The duct static shall be confirmed both through the instrumentation installed on the job and by the balancing contractor. Fan air flows shall be confirmed by duct pitot traverse. The system shall be tested in all operation modes (full return air, full outside air, modulated damper position, full cooling). Amperages shall be checked in all modes. The fan speed resulting in satisfactory system performance shall be determined at full design delivery. Inlet or outlet fan volume control dampers shall be in the wide-open position and one path presenting the greatest resistance to flow shall be fully open and unobstructed.
- C. Verify operation of each room thermostat/sensor serving fan coil units over full range of heating and cooling to ensure proper sequence of control of the unit.
- D. Final adjustments shall include, but are not limited to, the following:
 - 1. All Fans: Direct Drive
 - a. RPM with speed taps. Set fan speed on tap which most closely approaches design CFM. Report tap setting on equipment data sheet as high, medium or low.
 - b. RPM with speed control rheostat or EC motor potentiometer. Set output of fan at design CFM by adjusting the SCR or potentiometer. After adjustment, check fans ability to restart after powering down. Increase setting if required for proper starting. Mark setting on the adjustment device.
 - c. RPM with speed control by EC motor 0-10VDC external signal. Set output of fan at design CFM by determining the external EC motor speed signal. After adjustment, check fans ability to restart after powering down. Increase setting if required for proper starting. Balanced EC motor speeds shall be documented in the test and balance report as the applicable voltage (VDC) signal along with the corresponding air flow rates.
 - 2. Motor Starter
 - a. Mechanical Contractor Furnished
 - 3. Thermal Heaters
 - a. Magnetic and Manual Starters. Furnish and exchange thermals as required for proper motor protection.

- E. All major equipment performance tests shall be verified after system has been balanced and proper airflow rates established.
- F. Patch holes in insulation, ductwork, and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer. Report all damage requiring repair to the Division 23 contractor.

3.03 DOMESTIC HOT WATER RECIRCULATION

- A. Balance hot water recirculation pumps and all system balancing valves shown on plumbing drawings.

3.04 REPORT OF WORK

- A. Submit an electronic copy (or as required in Division 01) of the final testing and balancing report at least 15 days prior to the Mechanical Contractor's request for final inspection. All data shall be recorded on applicable reporting forms. The report shall include all operating data as listed in sections above, a list of all equipment used in the testing and balancing work, and shall be signed by the supervising engineer and affixed with his certification seal. Final acceptance of this project will not take place until a satisfactory report is received.
- B. The pitot tube traverse method for determining CFM shall be used and recorded wherever possible.
- C. Hydronic systems with meters: The system shall be balanced proportionally using the flow meters. On completion of the balance, the following information shall be recorded in the report: flow meter size and brand, required flow rate and pressure drop, valve settings on meters with a readable scale, flow rate in both full coil flow and full bypass modes.
- D. Hydronic systems without meters (thermal or terminal rated pressure drop balance): the system shall be balanced proportionally to the terminal ratings. On completion of the balance the following information shall be recorded in the report: design entering and leaving water temperature/pressure drop, final balance entering and leaving water temperature/pressure drop.
- E. When all hydronic balancing is done, all balancing valves shall be marked or the locking rings set.
- F. After all balancing is complete and all coordination with the contractor and the engineer is complete, furnish a bound report which shall contain the following information:
 - 1. RPM, drive sheave information (as installed and as changed), fan nameplate information, motor nameplate information, and amperage and voltage to all motors (in all operating modes).
 - 2. Static pressure across all components of the system.
 - 3. Original design and final balanced CFM at each system terminal. Include the terminal size, reading orifice size, and velocities read to attain the CFM.
 - 4. Pump and motor nameplate information, amperage and voltage to all motors, pressure drop across all system terminals, pressure rise across the pump in PSI and feet of head.
 - 5. Thermal protection for all motors shall be recorded. Starter brand, model, enclosure type, installed thermal heaters and the rating of the heaters, required thermal heaters and the rating of the heaters if different than installed shall be recorded. If the starters were furnished by the mechanical contractor, the heaters shall be changed to the correct size and so noted in the report. If the starters were furnished by the electrical contractor, the correct heater sizes shall be noted in the report and the electrical contractor shall be advised.
 - 6. The report shall include a sheet which shall report the method of balance, project altitude, and any correction factors used in the calculations.

7. A reduced set of contract drawings shall be included in the report with all terminals (VAV boxes, outlets, inlets, coils, unit heaters, fintube loops, radiant panel loops, etc.) clearly marked and all equipment designated. Indicate all duct pitot traverse locations by a number which shall match identification numbers utilized in balance report.

3.05 GUARANTEE OF WORK

- A. Guarantee the tests and balance for a period of 90 days from date of final acceptance of the test and balance report. During this period, the TAB Contractor shall make personnel available at no cost to the Owner to correct deficiencies in the balance or to help troubleshoot problem areas.

3.06 ADDITIONAL INSTRUCTIONS

- A. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for mechanical work.
- C. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.07 RETAINAGE

- A. Contract payment retainage will be withheld against the Mechanical Contractor until the final completion of this section of work has been demonstrated by the submission of the TAB report and an evaluation of its contents has been made by the Engineer.

END SECTION

**230700
HVAC INSULATION**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 23 3000: Air Distribution for lined ductwork requirements.

1.02 DESCRIPTION OF WORK

- A. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Flexible Elastomeric.
 - 2. Ductwork System Insulation:
 - a. Rigid and Flexible Glass Wool / Fiberglass.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials UL/ULC Classified per UL 723 or meeting ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
 - 3. Glass Wool / Fiberglass

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. Provide the following submittals:
 - 1. Piping Insulation.
 - 2. Pipe Fittings Insulation.
 - 3. Ductwork Insulation.
 - 4. Insulation Jackets.
 - 5. Sealants.
 - 6. Adhesives.
 - 7. Mastics.
 - 8. Field Applied Jackets.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. General:
 - 1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
 - 2. Insulation materials applied to carbon steel shall be Mass Load Corrosion Rate (MLCR) tested per ASTM 1617.

3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
5. All insulation materials installed within a plenum shall meet a flame spread rating of 25 and a smoke developed rating of 50 when tested per ASTM E84.

B. Piping Insulation:

1. Flexible Elastomeric Insulation:
 - a. Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1) Factory Applied Jacket:
 - (a) None.
 - 2) Field Applied Jacket:
 - (a) See requirements below.
 - b. Acceptable Manufacturers:
 - 1) Aeroflex: Aerocell
 - 2) Armacell: Armaflex AP
 - 3) K-Flex: Insultube

C. Ductwork Insulation:

1. Flexible Glass Wool / Fiberglass (Blanket) Insulation:
 - a. Glass Wool / Fiberglass bonded with a thermosetting resin. Comply with ASTM C 553, Type II; and ASTM C 1290, Type I, II, or III.
 - 1) Factory Applied Jacket:
 - (a) FSK – comply with ASTM C1136, Type II.
 - (b) PSK – comply with ASTM C1136, Type II. Permeance of 0.02 perms or less per ASTM E96.
 - 2) Field Applied Jacket:
 - (a) See requirements below.
 - b. Acceptable Manufacturers:
 - 1) Johns Manville: Microlite.
 - 2) Knauf Insulation: Atmosphere Duct Wrap.
 - 3) Owens Corning: SOFTR Duct Wrap.
 - 4) CertainTeed: SoftTouch Duct Wrap.
2. Rigid Glass Wool / Fiberglass (Board) Insulation:
 - a. Glass Wool / Fiberglass bonded with a thermosetting resin. Comply with ASTM C 612, Type IA and IB; and NFPA 90A and 90B. Provide 3.0 pcf density.
 - 1) Factory Applied Jackets:
 - (a) ASJ or AP – comply with ASTM C1136, Type I.
 - (b) FSK – comply with ASTM C1136, Type II.
 - 2) Field Applied Jacket:
 - (a) See requirements below.
 - b. Acceptable Manufacturers:
 - 1) Johns Manville: 800 Series Spin-Glas.
 - 2) Knauf Insulation: Earthwool Insulation Board.
 - 3) Owens Corning: Fiberglas Insulation Board.
 - 4) CertainTeed: CertaPro Commercial Board.

2.02 ADHESIVES

A. General:

1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Calcium Silicate Adhesive:
 1. Fibrous, sodium-silicate-based adhesive with a service temperature range of 50° F to 800° F.
- C. Flexible Elastomeric Adhesive:
 1. Comply with MIL-A-24179A, Type II, Class I.
- D. ASJ and FSK Jacket Adhesive:
 1. Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.03 MASTICS

- A. General:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Vapor-Barrier Mastic:
 1. Water based; suitable for indoor use on below-ambient services.
 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.04 at 40-mil dry film thickness.
 3. Service Temperature Range: Minus 20° F to plus 180° F.
 4. Solids Content: ASTM D 1644, 52 percent by volume and 62 percent by weight.
 5. Color: White.

2.04 SEALANTS

- A. General
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Joint Sealants for Metal Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40° F to plus 250° F.
 4. Color: Aluminum.
- C. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40° F to plus 250° F.
 4. Color: White.

2.05 FIELD-APPLIED JACKETS

- A. General:
 - 1. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket:
 - 1. Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. ASJ:
 - 1. All Service Jacket. Kraft paper face, fiberglass-reinforced scrim, with aluminum backing.
- D. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. 0.016" thick smooth finish.
 - c. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 2.5 mil thick polysurlyn.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate duct fitting covers only if factory-fabricated fitting covers are not available.
 - 2. Acceptable Manufacturers:
 - a. Ideal Products.
 - b. ITW Insulation Systems.
 - c. RPR Products, Inc.

PART 3 EXECUTION

3.01 GENERAL

- A. Inspection: Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Insulation Thickness: Pipe insulation minimum thickness shall be in accordance with the 2019 California Building Code and Title 24 requirements
- C. R Values and Conductivity: Insulation R values and thermal conductivity shall be in accordance with the 2019 California Building Code and Title 24 requirements

3.02 HVAC PIPING SYSTEM INSULATION

- A. General: Insulate HVAC piping per the following table:

HVAC PIPING INSULATION SCHEDULE					
System	Location	Type	Pipe Size	Thickness	Jacket
40°F-60°F	Interior	Elastomeric	All	1"	None

Refrigerant Suction Piping Refrigerant Hot Gas Piping	Exterior	Elastomeric	All	2"	Field Outdoor Aluminum
Notes: <ul style="list-style-type: none"> Interior location is inside of building thermal envelope. Exterior location is outside of building thermal envelope (i.e. rooftop or grade mounted piping). Refer to Equipment Insulation for valves and specialties. 					

- B. Insulation Omitted:
- Omit insulation on cold piping within unit cabinets provided piping is located over drain pan.
 - Omit insulation on hot piping within radiation enclosures or unit cabinets.
 - Omit insulation on steam condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections, and expansion joints.
 - Omit insulation on factory installed piping with-in HVAC equipment tested and rated in accordance with an acceptable test procedure
- C. Encase pipe fitting insulation with flame and smoke rated one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.

3.03 DUCTWORK SYSTEM INSULATION

- A. General: Insulate HVAC ductwork per the following table:

HVAC DUCTWORK LINER AND INSULATION SCHEDULE					
System	Location	Type	Thickness	Jacket	R-Value
Rectangular Supply, Return, Transfer Air Duct	Interior - all	Fiberglass Liner	1"	N/A	R-4.2
	Exterior	Rigid Glass Wool / Fiberglass	3"	Field Outdoor Aluminum	R-13.0
Spiral Round Supply, Return, Transfer Air Duct	Interior – Exposed	Fiberglass Liner	1"	N/A	R-4.2
Round Supply, Return, Transfer Air Duct	Interior – Concealed	Flexible Glass Wool / Fiberglass	1-1/2"	Factory FSK	R-4.2
Exhaust Air Duct	Unconditioned Spaces (attic, crawl space)	Flexible Glass Wool / Fiberglass	1"	Factory FSK	R-2.8
Notes: Interior location is inside of building thermal envelope. Exterior location is outside of building thermal envelope (i.e. rooftop or grade mounted ductwork). Refer to Section 23 3000 for fiberglass duct liner requirements.					

- B. Insulation Omitted:
- Do not insulate lined ductwork unless specified above.
 - Omit external insulation on return air ductwork in return air plenums.

3.04 INSTALLATION OF PIPING AND DUCTWORK INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on insulation, and protect to prevent puncture or other damage.
- F. Insulation Installation on Valves and Pipe Specialties: Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Apply insulation as follows.
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.
 - 5. Use removable jackets for insulation of valves and specialties where access is required for adjustment or maintenance. (IE pressure independent control valves)
- G. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation.
 - 2. Install with preformed pipe fitting covers as scheduled.
 - a. Overlap at longitudinal seams and end joints, for horizontal applications.
 - b. Seal with manufacturer's adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge
- H. Extend insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- I. Insulation should go through the hanger with the insert carefully placed in a notch in the insulation at the 6 o'clock position between the pipe and the shield. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.
- J. Install insulation and vapor barrier jackets continuous over piping at trapeze hangers.

3.05 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

- B. Replace and repair insulation disturbed by testing and balancing procedures required under Section 23 0593.
- C. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END SECTION

230923
TEMPERATURE CONTROL SYSTEMS - DCC

PART 1 GENERAL

1.01 SUMMARY

- A. Scope: This section contains general requirements for all work to be provided by the Temperature Controls Contractor.
- B. Refer to Section 23 0500 – Common Work Results for HVAC, for electrical, mechanical and temperature control contractor coordination of responsibilities.
- C. All communication wiring between DDC controllers, sensors and devices shall be hardwired as part of the complete system provided by the temperature controls contractor. Wireless controllers, sensors and devices shall not be permitted.
- D. The temperature controls contractor shall be responsible for providing and verifying all control sequences described in this section or in the Sequence of Operations regardless of whether the sequence uses the building automation system, unitary controls or third-party control systems, or any combination of systems. Any deviation from the sequence of operations, including limitations caused by the lack of ability of the building automation system to interact with unitary or third-party controls shall be clearly and prominently described as a deviation in the temperature controls submittal. The temperature controls contractor shall be responsible for coordinating and assuring the sequence of operations will be compatible with all equipment, including equipment purchased by other contractors. The temperature controls contractor will be responsible for correcting any interface problems that prevent the system from operating according to the sequence of operations.
- E. Work Included: It is the intent of this specification for the building automation system to be fully networked and installed as a complete package by the Temperature Controls Contractor. The system shall include all computer software and hardware, controllers, sensors, transmission equipment, system workstations, local panels, installation, engineering, supervision, commissioning, acceptance test, training, warranty service and, at the owner's option, extended warranty service.
- F. All controller hardware and software provided under this section shall be BACnet MS/TP compliant to provide the owner with an open, interoperable direct digital control system that will allow microprocessor control hardware and software from different control, fire alarm or card access system manufacturers to be integrated to this control system.
- G. The system shall be capable of supporting an unlimited number of clients using a standard Web Browser such as Internet Explorer or Netscape Navigator.
- H. Line Voltage: It is the intent of this specification for the temperature controls contractor to provide all wiring and conduit for the purpose of temperature controls, whether low voltage or line voltage (120vac or less). The temperature controls contractor shall coordinate with the Electrical Contractor to have the Electrical Contractor locate a junction box or boxes served by 120volt for the purpose of temperature controls. For devices that require line voltage (120vac or less) controls, the thermostat and wiring and conduit shall be the responsibility of the temperature controls contractor. If additional circuits/breakers are required it shall be the responsibility of the electrical contractor to provide. The temperature controls contractor shall not exclude line voltage controls in their proposal.
- I. Commissioning:

1. The project will have selected building systems commissioned. The equipment and systems to be commissioned are specified in Section 23 0800. The commissioning process and contractor responsibilities are described in Section 23 0800. The controls contractor shall cooperate with the commissioning authority for collection of trend data for short term monitoring. This may involve using the building automation system for a three-week period of trend data collection of points specified by the commissioning authority and/or providing temporary remote monitoring capabilities of the BAS to the commissioning authority (with a temporary software license if needed).

1.02 QUALIFICATIONS

- A. The control system shall be furnished, engineered, and installed by the manufacturer's local factory authorized office. The control contractor shall have factory trained technicians to provide instruction, routine maintenance, and emergency service within 48 hours upon receipt of request.
- B. Control system components shall be new and in conformance with the following applicable standards for products specified:
 1. American Society for Testing and Materials, ASTM.
 2. Institute of Electrical and Electronic Engineers, IEEE.
 3. National Electrical Manufacturers Association, NEMA.
 4. Underwriters Laboratory, UL (UL 916).
 5. FCC Regulation, Part 15, Section 156.
 6. National Fire Protection Association, NFPA.
 7. Local Building Codes.

1.03 SUBMITTALS

- A. General: Incomplete submittal packages will be returned un-reviewed. A partial submittal consisting of a damper and valve schedule will be accepted for projects with short construction schedules, provided a written request is submitted to the engineer. Submittal requirements are intended to eliminate or minimize engineering of either control hardware or software in the field, and shall be adhered to.
- B. Sequences of Operation Submittals: The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
 1. An overview narrative of the system generally describing its purpose, components and function.
 2. All interactions and interlocks with other systems.
 3. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 4. Written sequences of control for packaged controlled equipment.
 5. Sequences of control for the following modes of operation: Start-up, Warm-up, Cool-down, Normal Occupied, Unoccupied, and Shutdown.
 6. Capacity control sequences and equipment staging.
 7. Temperature and pressure control: setbacks, setups, resets, etc.
 8. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 9. Effects of power or equipment failure with all standby component functions.
 10. Sequences for all alarms and emergency shut downs.
 11. Seasonal operational differences and recommendations.
- C. Drawings: The controls contractor shall submit electronic generated schematic drawings in hard copy or electronic media for the entire control system, for review and approval before work shall begin. The hard copy drawings shall be submitted on 8½" x 11" or 11" x 17" sheets with drawing

information sized such that all drawing information is legible. The submittal drawings shall include the following:

1. A one-page diagram depicting the system architecture complete with a communications riser and peripheral devices.
 2. Floor plan layouts including locations of controlled equipment, communication bus and/or network wiring layout, thermostat locations, and terminal unit controllers with communication address identifiers.
 3. Mechanical room layouts including locations of controlled equipment, communication and network wiring layout, and panel locations with unit communication address identifiers.
 4. Point-to-point wiring diagrams for each HVAC system accurately depicting:
 - a. All temperature controls located on a schematic diagram of the controlled HVAC system.
 - b. Start-stop arrangement for each piece of equipment.
 - c. Equipment interlocks.
 - d. Wiring terminal numbers.
 - e. Special connection information required for properly controlling the mechanical equipment.
 - f. Control enclosure interior and exterior (face) layouts.
 5. A bill of material reference list with drawing tag identifiers, application description, manufacturer, model number, and quantity.
 6. Sequences of operation which shall identify each major component (hardware and software) involved in the control scheme by its tag identifier.
 7. Software flow diagrams for each sequence of operation. Provide detail of all parameters; of inputs, outputs, PID loops, and auxiliary control functions. This requirement applies to both text editing and function block programming types. DDC systems that utilize block programming shall submit the flow diagrams utilizing the actual object-oriented blocks, with a key of block types and block descriptions.
 8. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.
- D. Technical Data: The submittal shall also include manufacturers catalog data describing each item of control equipment or component provided and installed for the project. Include and identify all data needed to show adherence to the corresponding specification section.
- E. Damper Schedule: Provide a damper schedule with tag identifiers, application descriptions, damper sizes, damper arrangements, product type/name, actuator type, and actuator quantity for each damper. Include damper/actuator product cut sheets and identify all technical data needed to show adherence to the corresponding specification section.
- F. Valve Schedule: Provide a valve schedule which describes valve tag identifiers, application descriptions, specified GPM's, close-off rating, valve Cv ratings, pressure drop at rated Cv, port arrangement and actuator type for each valve. Include valve/actuator product cut sheets and identify all technical data needed to show adherence to the corresponding specification section.
- G. Specification Compliance: Irrespective of any prior approval to bid, the submittals shall include a specification compliance analysis for review and approval before work shall begin. The compliance document shall address each paragraph of Part 1, Part 2, Part 3, and Part 4 of the specification by indicating COMPLY, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the effect this has on the specified system performance. A schematic diagram showing the proposed system architecture and describing the expendability and capacity of the proposed system shall be included. The schematic shall have all non-applicable items clearly deleted and shall indicate the quantity of each component to be utilized to meet the requirements of this specification. The Engineer shall retain the right to accept or reject any listed exceptions to the specification.

- H. Acceptance Test Plan:
 - 1. Submit a detailed description of acceptance testing procedures that will be utilized to confirm proper operation of all sequences of operation and points, along with acceptance testing checkoff sheets.
 - 2. Provide a signed and dated certification to the Commissioning Authority (CA) and Owner's Project Manager (PM) upon completion of the control system checkout.
- I. Training Plan: Submit a detailed description of the training to be provided to Owner's personnel for the Engineer's approval. Plan shall include comprehensive details on: course outline, schedule, synopsis, training materials required/supplied and shall include the identity and credentials of the course instructor(s).
- J. Correction Period Support Plan: Submit a detailed description of the plan to support the owner during the correction period. Provide comprehensive details for: standard workday emergency problem response methods, planned preventative maintenance schedules, training and other plan information for the Engineer's approval.

1.04 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

1.05 WARRANTY

- A. See Section 01 7800 – Closeout Submittals, for general warranty requirements.
- B. Upgrades: Include all controller firmware and software updates for the installed system version at no additional cost to the system owner during the warranty period.

PART 2 PRODUCTS

2.01 BIDDING REQUIREMENTS

- A. Contractors wishing to bid temperature controls shall present a stand-alone temperature controls price.
- B. The temperature controls price may be predicated on using a particular brand of mechanical equipment, but must be clearly stated.
- C. An alternate price may be given in the event the desired brand of mechanical equipment is not used.
- D. Acceptable manufacturers:
 - 1. Allerton Controls
 - 2. Johnson Controls installed by Local Factory Office.
 - 3. KMC Controls
 - 4. Honeywell
 - 5. Delta Controls
 - 6. Distech Controls

2.02 SYSTEM ARCHITECTURE

- A. The complete electronic DDC temperature control system shall be comprised of five levels of control. Provisions for expansion of all levels of the DDC system shall be provided with this project such that a need for future "gateway" or "repeater" expansion hardware and software is not required:
 - 1. The First Level is comprised of electronic sensors, valves, dampers, actuators, switches, relays, and transducers, etc.
 - 2. The Second Level includes dedicated zone controllers for VAV box, and FTU units.
 - 3. The Third Level is comprised of local controllers for control of large primary mechanical systems such as air handling systems or heating/chilled water systems.
 - 4. The Fourth Level consists of the system controller(s) which are used for high level global programming functions and system networking.
 - 5. The Fifth Level is the System Workstation which includes the hardware and software necessary for an operator/engineer to interface with the control system.
- B. DDC control system shall be fully wired, wireless controls, sensors or devices are not acceptable.

2.03 SENSOR/TRANSMITTERS

- A. Network Sensors: Sensors shall be linear precision elements with temperature and humidity ranges appropriate for the application. Accuracy for temperature sensing within 1°F over the entire span: and accuracy for humidity sensing within 1% RH over the entire span:
 - 1. DDC zone network sensors shall be used for detection and control of zone temperature and zone humidity (where indicated) in each individual control zone. Where humidity sensing is not indicated provide temperature only network sensors.
 - a. Network sensors in administration office applications shall be provided with zone temperature indication via a digital display and shall have a warmer/cooler adjustment. The warmer/cooler adjustment shall be software limited to +/- 2°F.
 - b. Network sensors in all public areas shall be provided with a warmer/cooler adjustment. Sensors shall have blank covers with no display and the warmer/cooler adjustment shall be software limited to +/- 2°F.
 - c. Network sensors shall be provided with an occupied/unoccupied override pushbutton in administration areas and elsewhere where indicated.
 - 2. Network sensors shall be wired using the manufacturers standard communication cabling. Wireless sensors are not acceptable.
- B. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be looped across the coil, installed per the manufacturer's recommendation and fastened at a minimum of every 36 inches. Loops shall extend the full width of the coil and shall be spaced vertically no greater than 24". On large coils provide multiple averaging sensors as require for complete coverage of the coil.
- C. Sunshields shall be provided for outside air sensors.
- D. Thermowells for all immersion sensors shall be stainless steel or brass as required for application.
- E. The following are typical sensor application ranges:
 - 1. Space: 20°F - 100°F
 - 2. Outside Air: -40°F - 140°F
 - 3. Mixed Air: 20°F - 100°F
- F. Differential Pressure Sensor: Differential pressure sensor shall be temperature compensated and shall vary the output voltage with a change in differential pressure. Sensing range shall be

suitable for the application with accuracy of +/- 2% of range and repeatability of +/- 0.5% of range. Sensor shall be capable of withstanding up to 150% of rated pressure for air applications and 300% of rated pressure for water applications without damage.

- G. Humidity Sensors: Humidity sensors shall be of the solid-state type using a hygroscopic polymer sensing element. The sensor shall vary the output voltage with a change in relative humidity. Sensors shall be available for room or duct mounting, with a minimum range of 30% - 80% ± 5%.
- H. Air Velocity Sensors: Sensor shall use thermal anemometry to determine air flow rate. Repeatability shall be ± 25 FPM; accuracy ± 5% of range. The anemometer shall use constant temperature differential technology and operate from 30°F to 120°F.
- I. Carbon Dioxide Sensor:
 - 1. Sensor shall be self-calibrating. Sensor shall be designed to monitor CO2 levels, in accordance with ASHRAE Standard 62-2001, have a 4-20 mA output, have an accuracy at 20°C < (40ppm +/- 3% of reading), and a range of 0-2000 PPM, adjustable to 20,000 PPM.
 - a. Duct Mounted type: Viasala GMD20 or approved equal.
 - b. Wall mounted type: Viasala GMW80, or approved equal.
- J. Occupancy Sensor: Occupancy sensor shall be of the passive infrared or ultrasonic receiver type. As a minimum the occupancy sensor shall provide adjustments for timed-on delay and sensor sensitivity.
- K. Provide all wall mounted sensors including network sensors, thermostats, humidistats, and CO2 sensors in unsupervised public spaces with cast guard or plastic cover or wire cage type protective covers. Guards shall be key lockable and rigidly secured to wall using tamper resistant hardware and base. Spaces requiring guards include but are not limited to corridors, gymnasiums, cafeteria, stage, entry lobbies and entry vestibules.

2.04 AUXILIARY ELECTRIC CONTROL DEVICES

- A. Control Relays: Shall be UL listed plug-in type with dust cover, LED "energized" indicator and integral H-O-A switch. Contract rating, configuration and coil voltage shall be suitable for the application.
- B. Manual Control Switches: Shall be UL listed for use in NEMA 1 enclosures with contact arrangement and rating suitable for the application. Bat handle or knob actuator with nameplate clearly identifying function of each switch position.
- C. Line Voltage Thermostats: Line Voltage Thermostats shall be U.L. listed with SPDT contacts, switching at an adjustable setpoint with a range of 55° to 85°F. Provide lockable guards for all thermostats located in areas where mechanical damage or tampering may occur.
- D. Differential Pressure Switches: Pressure differential switches (air or water service) shall be UL listed, DPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified. Switches shall be capable of withstanding up to 150% of rated pressure for air applications and up to 300% of rated pressure for water applications. Duct high pressure switches shall be provided with contacts that require manual resetting.
- E. Current Sensing Relays: Current Sensing Relays shall be U.L. listed and of the proper range. The switch output contact shall be rated for 30VDC. Threshold setting shall be fully adjustable within the selected range. Response time shall be 0.25 seconds or less. Provide current sensing relays on all fans and pumps for status sensing unless otherwise noted.

- F. Low Temperature Thermostats: Low Temperature Thermostats shall be U.L. listed, DPDT snap-acting, pilot duty rated (125 VA, minimum), NEMA 1 enclosure with manually adjustable set point and differential suitable for the application or as specified. Switches shall be actuated by the coldest 1' of a 20' capillary and shall be provided with contacts that require manual resetting. The element shall be properly supported to cover the entire downstream side of the heating coil with a minimum of three loops. Separate thermostats shall be provided for each 25 square feet of coil face area or fraction thereof. The setpoint shall be 25°F unless otherwise specified on the plans or sequence of operation.
- G. Flow Switches: Flow Switches shall be U.L. listed and shall be of the paddle type equipped with DPDT contacts to establish proof of flow. Flow switches shall be of the vapor-proof type.
- H. Control Transformers: Shall be UL listed Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
- I. Damper End Switches: Shall be UL listed line voltage SPDT snap-acting pilot duty rated (125 VA minimum) NEMA 1 enclosure, with roller type actuating arm suitable for damper position application.
- J. Push/pull Boiler Room/Chiller Room Emergency Stop Switch: Large, heavy duty push – pull to reset, 24V, with non-locking hinged cover to prevent accidental trip. Provide NEMA 1 enclosure for all indoor applications and weather tight NEMA 4X for all outdoor applications. Wall plate shall indicate “EMERGENCY BOILER SHUTDOWN” or “EMERGENCY CHILLER SHUTDOWN”. Provide with auxiliary contacts for BAS monitoring.
 - 1. Pilla model BSD120 or equal.
- K. Smoke Detectors: Shall be as specified in the schedule of responsibilities:
 - 1. Smoke detectors located in air handling units or ducts shall be complete with duct-mounting accessories as recommended by manufacturer. Provide multiple units for larger duct areas consistent with manufacturer's recommendations.
 - 2. Provide all control interlock wiring from fire/smoke alarm system relay contacts to HVAC controls unless this wiring is noted in the Division 26 plans or specifications
- L. Outside Air Measuring Stations (Where not integral to the equipment)
 - 1. Basis-of-Design Product: Provide Paragon Controls Inc.; MicroTrans EQ or equal.
 - 2. Span: Factory calibrated to match the application.
 - 3. Accuracy: 0.25% of full scale including non-linearity, hysteresis, deadband and non-repeatability.
 - 4. Signal Conversion Resolution: 24-bit A/D and 12-bit D/A.
 - 5. Temperature Effects: Less than 0.03 percent full scale per deg F (Less than 0.045 percent full scale per deg C).
 - 6. Over-pressure: 15 psid proof, 25 psid burst.
 - 7. Noise Filtration: Response time to reach 98 percent of a step change adjustable from 0 to 200 seconds in 1 second increments.
 - 8. Output: 4-20 mA or 0-10 Vdc.
 - 9. Enclosure: NEMA 1 rated flame-retardant ABS plastic.
 - 10. Capable of twelve-point linearization and four-point flow correction.
 - 11. Large backlit LCD for configuration and local indication of measured process.
 - 12. Six button touch pad and password protected menus for field configuration of engineering units, process noise filtering, operating range, and alarm set points.
 - 13. Automatic Zeroing Circuit: For operating velocities below 1,266 fpm, include an automatic zeroing circuit that is field configurable for frequency of activation between one and twenty-four hours on 1-hour intervals. Signal processor output shall be locked and maintained at last given output value during automatic zeroing period so as not to interrupt automatic control process. Meter shall be auto calibrated to accuracy of plus or minus 1 count.

14. Monitoring and configuration shall be performed through BACnet MS/TP communication network.

2.05 CONTROL DAMPERS

- A. Motorized dampers, unless otherwise specified elsewhere, shall meet the following:
 1. Frame of 16-gauge steel structural hat channel.
 2. Blades of 14-gauge galvanized steel, roll-formed airfoil-type design with extruded vinyl blade edge seals mechanically locked into the blade edge.
 3. Stainless-steel (28-gauge minimum) jamb seals of flexible, compression type.
 4. Control shaft shall be 1/2" dia. removable shaft. Linkage shall be located outside of airstream.
 5. Leakage shall be a maximum of 0.10% of maximum flow based on a pressure differential of 1.0" w.g.
 6. Airfoil type dampers shall be used for any applications where the air velocities are greater than 1500 FPM.
 7. Provide a minimum of one damper actuator per damper section.
- B. Unless otherwise scheduled, the control dampers for outdoor/return air mixing box dampers shall be parallel blade, arranged to direct airstreams towards each other. Dampers used for air volume or pressure control modulating applications shall be opposed blade type. All other dampers may be parallel or opposed blade type.
- C. Damper Actuators:
 1. Electric actuators shall be direct coupled typed.
 2. Unless otherwise noted, all actuators must be spring return type. Under no circumstances shall capacitors or batteries be used in lieu of spring return.
 3. Actuators for VAV terminal control may be non-spring return.
 4. Feedback: Where indicated, provide motorized damper actuators with ability to monitor position as a DDC system analog input on the actuator.

2.06 LOCAL CONTROL PANELS

- A. All relays, switches, transducers and other field interface devices, for equipment located within the mechanical equipment rooms, shall be panel mounted. Each local control panel shall have door mounted devices as shown on the drawings. Provide a convenience 120 VAC receptacle in each panel. All electrical devices, within the panels shall be wired to a numbered terminal strip. All wiring within the panel shall be run in wiring tray in accordance with NEMA and UL standards, and shall meet all local codes. Panels shall be NEMA type suitable for applications as required. Provide a final as-built control drawing, reduced, laminated, and mounted inside of the panel door. Provide panel with 20% spare mounting capacity.

2.07 MISCELLANEOUS

- A. The Controls Contractor shall furnish all electric relays and coordinate with the supplier of magnetic starters for the auxiliary contact requirements. All electric control devices shall be of a type to meet current, voltage, and switching equipment of their particular application. Relays shall be provided with 24 VAC coils and contacts shall be rated at 10 amps minimum.

2.08 ZONE CONTROLLER HARDWARE

- A. General: Each HVAC Zone Controller shall be a stand-alone DDC controller. The controller shall include all hardware and software required for communications with the system controller. An individual zone controller shall be dedicated for each zone terminal device. Individual zone

controllers are not required for constant volume duct reheat coil applications, but may be provided at Temperature Control Contractor's option.

- B. Programs: The control program shall reside in the zone controller. The application program shall be maintained in ROM. The default database, i.e. setpoints and configuration information, shall be stored in EEPROM. Controllers requiring local setting of potentiometer or dip switches for control strategies are not acceptable. No batteries can be used for memory protection.
- C. Stand-Alone: Controllers requiring the application or database to be downloaded from a host or share processing with a "master controller" shall not be acceptable. After a power failure the zone controller must run the control application using the current setpoints and configuration.
- D. Communications: Communication to the system controller shall be 9600-baud asynchronous.
- E. Input-/Output: Each zone controller shall have the necessary quantities of inputs and outputs for the selected duty. Inputs shall be individually electrically isolated from other inputs, outputs, communications, and power. All inputs shall feature an auto-calibrate function to eliminate sensing errors.
- F. Connections: All electrical connections shall be made to the combination terminal strip and base assembly. To ensure long term reliability, all electrical terminations shall be screw type.
- G. The logic card, containing all active electrical components, shall be easily installable and removable from the wiring base, without the use of tools or the removal of any electrical wiring. Products that require disconnection of wiring from logic card before removal will be required to supply and install a quick disconnect type inter-connection.
- H. All controllers shall be interoperable controllers bearing the applicable BACnet logo on each controller that is provided.

2.09 ZONE CONTROLLER SOFTWARE

- A. The zone controller software shall be provided with the capabilities required by the specific application.
- B. Each input, output or calculation result shall be capable of being assigned to the network controller for system networking.

2.10 LOCAL CONTROLLER HARDWARE

- A. General: The Local Controllers shall be a local control loop microprocessor-based controller installed at each mechanical system; i.e., air handling unit, heating boiler, chiller. The controller shall execute local control sequences, independent of a workstation. All control loops and setpoints shall be stored in EEPROM or other non-volatile field reprogrammable memory. Each controller shall be addressable by a workstation or a portable laptop computer. Where local controllers are used for constant volume duct reheat coil applications, group reheat zones to a local controller by floor, air handling unit, service, etc.
- B. Scan: Controller shall continuously scan and maintain the most recent data in EEPROM for retrieval by a remote workstation and by the local controller software programs.
- C. Isolation: Control, communication, and power circuits for each controller shall be individually electrically isolated to protect against transients, spikes, and power surges. All inputs and outputs shall be individually optically isolated from other inputs and outputs, power, communication, and field wiring. Optical isolation shall be provided either as an integral

component of the controller or provided as a separate interface device between the controller and field wiring.

- D. Servicing: For ease of servicing, each Controller shall consist of a removable plug-in circuit board. Products which require disconnection of wiring from the local controller logic card before removal shall supply and install a quick disconnect type interconnection.
- E. All controllers shall be interoperable controllers bearing the applicable BACnet logo on each controller that is provided.
- F. Database: All field control database shall be entered, changed or downloaded to the local controllers via a portable service tool or system workstation.
- G. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.
- H. Input/output Modules: Provide the following input/output capabilities:
- I. Universal inputs which can accept industry standard analog signals (4-20 mA, 0-5 VDC, etc.) and binary contact closures:
 - 1. Digital outputs may be latched or momentary contact type.
 - 2. Analog outputs shall have a 1% resolution over total output span of 100%.

2.11 LOCAL CONTROL SOFTWARE

- A. General: Provide complete controller software to execute all mechanical system local loop controls functions.
- B. Control Parameters: The software blocks in the local controller shall produce all of the necessary reverse acting and/or direct acting PI2 signals as required by the control sequence. The proportional and integral values which make up the PI2 output value shall be readable and modifiable, at the system workstation or the portable service tool to facilitate tuning of control loops.
- C. Networking: Each input, output, or calculation result shall be capable of being assigned to the system controller for system networking.
- D. Programming Functions: Provide the following standard temperature control loop programming functions:
 - 1. Control Block Programming.
 - 2. PI2 or PID Control.
 - 3. Serial Load Staging.
 - 4. Binary Load Staging.
 - 5. Analog Load Staging.
 - 6. Master-Submaster Routines.
 - 7. Anti-Windup for Integrated Loops.
 - 8. Weekly/Daily/Holiday Scheduling.
 - 9. Optimum Start/Stop Programming.
 - 10. Automatic Trending with Adjustable Sample Rates.

2.12 SYSTEM CONTROLLER HARDWARE

- A. General: The system controller shall be a microprocessor based, multi-tasking real time system controller that provides advanced system programming, uplink and downlink communication, polling and other supervisory functions for zone and local controllers. Provide the system

controller with a minimum 9600 baud auto-dial auto-answer modem for remote network access and remote alarm reporting.

- B. Operating Environment: The control shall be capable of operating in an environment of 32° to 122°F and 10 to 90% relative humidity non-condensing.
- C. Power Loss/Restart: The controller shall be tolerant of power failures. Memory shall be non-volatile or unit shall hold memory of to 30 days minimum on back-up batteries. When a power failure has occurred and power (normal or emergency) is restored, automatically and without operator intervention, the controller shall execute the following restart procedures:
 - 1. Come on line.
 - 2. Update all monitored functions.
 - 3. Implement special building start-up strategies as required.
 - 4. Resume operation based on current time and status.
- D. Stand-Alone: The controller shall be a true no-host system that does not require a PC or "Host" computer to perform any control functions or communications.
- E. Isolation: Field communication ports shall be individually electrically isolated to protect against transients, spikes, and power surges. The ports shall be optically isolated from each other, the controller circuit board and from power wiring. Optical isolation shall be provided either as an integral component to the controller or provide as a separate interface device between the controller and field wiring.
- F. Self Diagnostics: The controller shall contain in this program, a self-test procedure for checking communications and verify the functionality of the CPU memory and database.
- G. The system controller shall be the integration point for ASHRAE Standard 135-1995 BACnet MS/TP technology communication protocols. The system controller shall also provide all tools for Java enabled Web browser access via the local area networks (Intranet) and wide area networks (Internet).
- H. Graphical User Interface (GUI):
 - 1. The GUI shall be completely icon driven, multi-tasking and employing a graphical operating environment. The GUI shall not only be for real-time access to any system(s) on the LAN but shall also allow the operator an easy method of information management. Information management shall mean the massaging and manipulation of any system real time or historical data into integrated applications such as report generators, spreadsheets, X/Y charts, database managers, etc. Complete file management and data transfer, such as copying, moving files, automatic and manual means of "cutting and pasting" of data items from one application to another shall be provided as an integral part of this GUI. This GUI shall be completely Windows "compliant":
 - a. Menu and System Access:
 - 1) This GUI shall provide an easy and absolute method of menu and system access. The menu system shall provide the entry point into the entire GUI array of applications and programs. All the GUI programs and Windows programs shall be accessible through this menu system.
 - 2) This menu system shall be able to call any operator specific menu or menus allowing complete versatility in how the menu structure is designed and used.
 - b. System Security:
 - 1) System security shall be on an application by application basis. During the setup or editing of a particular user the owner shall be able to enable or disable the use of any application or function within an application for each user of the system. Each user security access record shall list each of the applications to which the user has access and the functions that are permitted from within each of these

- applications. The users shall be assigned discrete passwords in order to have access to any particular application or function within the system.
- 2) As well as application protection each user shall be assigned to a personalized menu (see Menu and System Access). This shall allow for each user to have their own discrete menu system for access into the various applications and dynamic graphic screens.
- c. Dynamic Graphics:
- 1) The dynamic graphic portion of this GUI shall allow the operator to access any system information via a system penetration method. System penetration shall allow the operator to begin at an entire site plan and then zoom in to a particular area for closer inspection and then further zoom in on this area and so on until the detailed color graphic display of a desired portion of the facility is represented.
 - 2) As a minimum a graphic screen shall be designed showing the building, each floor, each major piece of mechanical equipment within each building that is being monitored/controlled, all of which will display the data for each area dynamically.
 - 3) Dynamic point display shall be user selectable from at least the following options: standard text readout, font, style, size, foreground and background colors, border style, plus discrete movement animation allowing animation displays for items such as dampers, gauges, fans, switches, lights, alarm activity, etc.
 - 4) Each mechanical and electrical system that is monitored/controlled by the system shall have a unique dynamic color graphic. The display will be provided by the control contractor and approved by the engineer.
 - 5) The graphical user interface shall allow the user to easily create new displays and modify existing displays. A library of standard HVAC equipment, control devices, mechanical systems, tables, lines, circles, rectangles, squares, arrows, etc. shall be provided to allow easy implementation of the changes/additions to the system.
 - 6) The program shall allow any standard JPG or GIF file to be displayed with dynamic data overlaid on to the display.
- d. Centralized Scheduling and Modification:
- 1) Calendars shall be provided for displaying and modification of any of the controller's time clock functions. Holidays and special functions shall be clearly marked on the calendar. Changes shall be permanent or, for one time or multiple occurrences. Global changes shall be allowed for similar schedules.
- e. Alarm Annunciation:
- 1) Upon the incidence of an alarm an alarm window shall be displayed showing the point in alarm, the time and date of the alarm and a user -selected predefined alarm message (and optionally printed to a user defined printer, printers and/or dumb terminal devices). Alarms shall be displayed regardless of the application in use including any Windows applications. The program shall display the unacknowledged alarms. The user shall be able to selectively enable or disable the alarm reminder in the event there are unacknowledged alarms.
 - 2) Acknowledgment of alarms shall be from an alarm "pop-up" display and/or from a separate alarm summary. Acknowledgment shall be by a specific event, date range, class, or specific alarm definition and condition. Upon acknowledging the alarm, the name of the operator acknowledging the alarm and the time and date will be associated with the acknowledgment. This data will be stored to the alarm history file and printed to the chosen printers or terminal devices.
 - 3) Automatic or manual display of associated dynamic graphic screens shall be provided for each alarm upon the alarm occurrence.
 - 4) The user shall be automatically placed back to the application or graphic in use at the time of alarm occurrence upon exiting the alarm handling mode.
 - 5) A current alarm summary shall be provided which will dynamically display only alarms that are currently in alarm. As alarms are returned from their respective

- alarm states the current alarm summary shall be dynamically updated to reflect the change.
- f. Trend Management:
 - 1) The GUI shall automatically perform time based periodic collection of real time point data and subsequently store it to the systems hard disk.
 - 2) Storage and manipulation of sampled points shall only be limited by disk space. Sampling rates shall be user selectable from instantaneous (once a second) to longer periods of time such as one week. Collection of data shall be user selectable to start and stop on specific times and dates.
 - 3) Charting of the trend data shall be an integral part of the trend management program. Third party graphing packages such as Excel or Lotus 123 shall not be required to implement this program. Multiple points shall be capable of displaying on the same chart. Multiple X/Y charts may be run simultaneously displaying either real time data (instantaneous) or historical. X/Y scaling shall be either automatic or user selectable for any chart displayed, each chart may have different scaling. X scales shall be user selectable allowing for display of data over a wide range of times and dates. Display of multiple years of data shall be allowed. The chart display shall be capable of displaying a window of time for multiple years.
 - g. Multi-tasking:
 - 1) The GUI shall be capable of true multi-tasking capabilities. The user shall be able to use other non-related programs while still running all GUI applications with no interruptions. This shall include the use of real time data in other applications.
 - h. The user interface shall employ Web browser-like functionality for ease of navigation. This interface shall include, but not be limited to, forward/backwards buttons, home button and a context sensitive locator line (similar to a URL line).
 - i. Graphic screens on the Web Browser client shall support hypertext links to other Web pages on other Internet or Intranet sites.
 - j. User log-on identification and passwords shall use Java authentication techniques to prevent unauthorized access.

2.13 SYSTEM CONTROLLER SOFTWARE

- A. General: The network controller software shall be multi-tasking, menu-driven, in English language. The software shall operate on a database comprised of control blocks which resemble control hardware devices (receiver controllers, gradual relays, higher or lower of two pressure relays, time delay relays, etc.). The Controls Contractor shall configure these control blocks to attain the proper sequence of control. The user shall be able to add, delete, or modify all control blocks on-line as required.
- B. Passwords: Provide a minimum of multiple levels of user definable passwords.
- C. Help Menu: On-line location sensitive help shall be provided for each menu item, describing the consequences of making the highlighted menu selection.
- D. Login: A login message shall be displayed every time the workstation is connected to a network controller.
- E. Backup and Restore: The database in each network controller shall be uploaded to the System Workstation, for archival purposes, and shall be re-downloaded to each network controller at any time. Operating system changes, parameter changes, upgrades and enhancement for network controllers shall be downline loadable from the System Workstation, or via dial-in from a remote location.
- F. Programming Functions: The software blocks shall provide all the necessary mathematics, logic, utility, and control functions necessary for proper sequence of control. These functions shall be

contained in the network controller operating system to be available in any combination for field programming the unit through RAM memory. As a minimum, these routines shall include, but not be limited to, energy management strategies such as:

1. Time or Event Based Scheduling.
 2. Adaptive Optimum Start/Stop.
 3. Demand Limiting/Load Shedding.
 4. Enthalpy Control.
 5. Hot Water/Outdoor Air Reset.
 6. Run Time Totalization.
 7. Alarm Detection and Dial Out.
 8. Night Setback.
 9. Historical Trending.
- G. Alarms: The network controller shall be capable of comparing analog and digital readings to predetermined high and low limits and annunciate each time a value enters or returns from an alarm condition. Unique high and low limits shall be supplied for each analog point in the system. The system shall be capable of suppressing selected alarm reporting when the primary equipment from which the alarm point is based is in the inactive state. The alarm features of the network controller software shall, as a minimum, provide the following:
1. Digital, Analog, and Hi/Lo settings and deadband.
 2. Sliding Alarm Limits.
 3. Conditional Alarming.
 4. Alarm inhibiting through feedback loop.
 5. Fluttering Alarm Suppression.
 6. Separate Tailored Alarm Messages for each alarm.
 7. Auto dial of any alarm condition to a minimum of 10 phone numbers.
- H. Communication Diagnostics: The network controller software shall be programmed for self-diagnosing of failure, automatically without query by the operator. In the event of communications failure or limited power failure, the system shall be capable of both notifying a local operator of the specific occurrence, as well as auto dialing the condition to a remote site. Auto-dial out shall be configurable to repeat the alarm while the situation remains unattended and unacknowledged. In addition to automatic self-diagnostics, communications statistics on zone and general application controller communications shall be maintained. These statistics shall tabulate total communications attempted versus successful and unsuccessful communications by unit number. The option to reset communications statistics to zero (0) at any time shall be provided.
- I. Interfaces to Other Manufacturer's Equipment: Where specified, each Network Controller shall be equipped with standard software blocks with which to interface to other manufacturer's equipment. The software blocks shall be defined by the Controls Contractor to read/write analog values and digital status to/from other manufacturer's equipment for alarm, trend, operator advisory, graphic display and other system uses. Communications between the Network Controller and other manufacturer's equipment shall occur in the same manner and with the same software as that used for communications with Dedicated and General Application Controllers.
- J. The software shall employ object-oriented technology for representation of all data and control devices within the system. In addition, adherence to industry standards for ASHRAE BACnet is required to assure interoperability between control system manufacturers. The control contractor must provide a PICS document showing the installed system's BACnet compliance level of 3.
- K. The software must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
- L. The software shall allow alarms to be routed to E-mail messages and paging services.

- M. Access to the system controller shall be via the Internet from a remote location and from a local computer operator's station (when specified) by direct connection to an Ethernet LAN. The control contractor shall provide a connection to the Internet to enable this access via high-speed modem or via the Intranet to a corporate server providing access to an Internet Service Provider. The owner shall pay monthly access charges for the connection and service provider.

2.14 WIRING AND CONDUIT

- A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 Volt
Communications	Per Mfr.	Per Mfr.

- B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
- C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
- D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2-inch galvanized EMT. Compression fittings shall be used for interior locations and watertight compression fittings for exterior locations. Provide conduit seal off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
- E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- F. Junction boxes shall be provided at all cable splices, equipment terminations, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location J-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
- G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.

2.15 COAXIAL CABLE

- A. Coaxial cable shall conform to RG62 or RG59 rating.
- B. Provide plenum rated coaxial cable when running in return air plenums.

2.16 FIBER OPTIC CABLE

- A. Acceptable fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140. Only glass fiber is acceptable, no plastic.

- B. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

2.17 ENCLOSURES

- A. All controllers and field interface panels shall be mounted in new enclosures unless otherwise stated in this specification.
- B. All outside mounted enclosures shall meet the NEMA-4 rating.

PART 3 EXECUTION

3.01 PROJECT MANAGEMENT

- A. Provide a project manager who shall, as a part of his duties, be responsible for the following activities:
 - 1. Coordination between the Contractor and all other trades, Owner, local authorities, and the design team.
 - 2. Scheduling of manpower, material delivery, equipment installation and checkout.
 - 3. Maintenance of construction records such as project scheduling and manpower planning and AutoCAD for project co-ordination and project record drawings.

3.02 SYSTEM SETUP AND INSTALLATION

- A. System setup and installation shall include but is not limited to the following:
 - 1. Database entry and database setup of all input and output points, including alarm printouts with individual alarm messages, as described on the input/output point list.
 - 2. Programming and full setup of all sequences described in the sequence of operation section of the specification as shown in 230993 - Sequence of Operation & Points List.
 - 3. Complete checkout and testing of all functions, operations and features of the building automation system as described in this specification including, but not limited to, all features and functions utilized in the system setup as well as features and capabilities of the software and hardware described as provided and installed but not implemented or used at this time.
- B. Pre-Programmed Trend Plots:
 - 1. The Temperature Control Contractor shall add a pre-programmed trend plot at the system workstation GUI for RTU-1, MAU-1, ERV-1. Trend plot shall contain a data entry box and adjoining "trend plot" button so user can immediately display a 24-hour trend plot (5-15 min interval) for any day in the preceding year. Include all unit and space temperature sensors; all unit, space and building pressure sensors; outside air temperature sensor; all component/stage on/off status; fan speed; damper positions and other pertinent information.

3.03 WIRING INSTALLATION METHODS

- A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.
- B. The term "control wiring" is defined to include the providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices as follows:
 - 1. Consist of wiring in pilot circuits of contractors, starters, relays, etc., and wiring for valve and damper operators.

2. For single phase devices where power current passes through controller, wiring between controller and device shall be considered control wiring; wiring to device from electric panel shall be considered power wiring.
- C. Install control wiring system in conduit for electric/electronic control systems. Conceal wiring/conduit, except in mechanical rooms and areas where other conduit and piping are exposed. UL plenum rated cable shall be allowable in air plenums as approved by local codes. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Provide shielded cabling where required to prevent noise from being superimposed on control system wiring. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, or the electrical conduits is not acceptable. Wiring buried in slab on grade concrete or explosion proof areas shall be in rigid metal conduit. Provide adequate strain relief for all field terminations.
- D. Number-code or color-code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.
- E. All line voltage power wiring required because of substitution of equipment specified in this section, shall be provided by this section.

3.04 CONTROL DEVICE LOCATIONS

- A. Adjustable sensors and thermostats shall be mounted according to the requirements of the Americans with Disabilities Act (ADA) and the American National Standards Institute (ANSI) requirements. The contractor shall submit coordination documents to the architect indicating intended sensor/thermostat locations including intended mounting heights for architect review and approval. Upon completion of the architect's comments, the documents shall be submitted to the mechanical engineer for final review.
- B. Remote control devices not in local panels shall be accessible for adjustment and service – below 7' above finished floor whenever possible.
- C. Locate all temperature control devices wired under Division 26.
- D. Local control enclosures shall be mounted at eye level for accessibility and service, and located within 50 feet of the system served, unless otherwise shown on the plans.

3.05 IDENTIFICATION

- A. All control equipment shall be clearly identified by control shop drawing designation as follows:
 1. Control valves and damper actuators - brass tags or engraved bakelite tags
 2. Other remote-control devices - metal tags or laser printed, adhesive backed, metalized polyester film labels.
 3. Control Enclosures - engraved nameplate with panel number and system served.
 4. Control Conduit Junction Boxes - Painted medium blue.
 5. All thermostats and temperature sensors shall be clearly marked with an engraved nameplate as to which device it serves (VAV terminal, cabinet unit heater, FTU, etc.). Final device designations shall be coordinated with owner prior to nameplates being engraved.

3.06 MOUNTING AND INSTALLATION PRACTICES FOR DEVICES

- A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.

- B. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
- C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
- D. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
- E. Outdoor air sensor shall be placed in a location approved by the engineer.

3.07 LOCAL CONTROL PANELS

- A. All relays, switches, transducers and other field interface devices, for equipment located within the mechanical equipment rooms, shall be panel mounted. Panels shall be NEMA type suitable for applications as required with hinged door and key-lock latch. Size for 20% spare mounting capacity.
- B. Manual switches and indicating devices shall be flush-mounted on the panel face. Provide engraved bakelite or lithographed metal nameplates for all items on the panel face with white 1/2-inch-high letters on a black background. Paper or embossed labels are not acceptable.
- C. Mount internal components securely on steel removable sub-panels. Each component shall be individually labeled with function and device identification, as shown on the control shop drawings. Label information shall be printed with a laser printer on adhesive backed metalized polyester film. Paper or embossed labels are not acceptable.
- D. Interconnections between internal and face-mounted devices pre-piped and wired with color-coded tubing/conductors shall be neatly installed in plastic tray and/or tie-wrapped. All wiring within the panel shall be run in wiring tray in accordance with NEMA and UL standards, and shall meet all local codes. Terminals for field connections shall be UL listed for 600V service, individually identified per control shop drawings, with adequate clearance for field wiring. Control air terminations for field connection shall be individually identified control shop drawings.
- E. Provide a convenience 120 VAC receptacle in each panel, a fused on/off power switch, and main air gauge for control power sources to each local panel. Provide a final as-built control drawing, reduced, laminated, and mounted inside of the panel door.

3.08 MOUNTING AND INSTALLATION PRACTICES FOR ZONE AND LOCAL CONTROLLERS

- A. Controllers are to be mounted vertically.
- B. The 120 VAC power wiring to the network of Controllers shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral, and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
- C. Utilize a true earth ground. Do not use a corroded or galvanized pipe, or structural steel.
- D. Controllers will be clearly labeled with the model number of the controller. In addition, all status lights will be identified with labels to indicate their function.

3.09 SOFTWARE INSTALLATION

- A. The Contractor shall provide all labor necessary to install, initialize, start-up, and debug all system software as described in this section. This includes any operating system software or other third-party software necessary for successful operation of the system.

3.10 SYSTEM ACCEPTANCE

- A. General: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Engineer requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing shall commence at a mutually agreeable time within ten (10) calendar days of request. When the test procedures have been demonstrated to the Owner's representative and pass, the system will be accepted. The One-Year Warranty Support Plan shall begin at this time.
- B. Acceptance Test Procedures: DDC control panels shall be demonstrated via a functional end-to-end test. Prior to an acceptance test review by the Engineer, the contractor shall submit a point by point checklist to the Engineer with descriptions of how the following tests were performed. Such that:
 - 1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their portion verified.
 - 2. All analog input channels shall be verified for proper operation.
 - 3. All digital input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
 - 4. Automatic control operation of PID control loops shall be verified by introducing an error or change into the system and observing the proper corrective system response.
 - 5. Automatic control operation of sequences of operation shall be verified by introducing an error or change into the system and observing the proper corrective system response.
 - 6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
 - 7. Communication with each DDC control panel shall be demonstrated.
 - 8. All available and specified system reports and logs shall be demonstrated at the system workstation.
 - 9. Correct system start-up and shutdown procedures shall be demonstrated.
 - 10. All controllers shall be demonstrated to operate in a standalone mode.
 - 11. Workstation Operator commands will be explained and demonstrated.
 - 12. If any point or sequence should fail testing, perform necessary repair action and retest failed point and all interlocked points.
- C. Project Record Documentation: After a successful acceptance demonstration, submit project record drawings of the completed project for final approval. After receiving final approval, supply three (or as specified in Division 01) complete project record drawing sets (maximum ANSI "D" size), together with AutoCad diskettes to the owner. The original master site software license and disposition of any required software keys shall be included.
- D. Operation and Maintenance Manuals: Submit six (6) copies (or as specified in Division 01) of operation and maintenance manuals. Include the following:
 - 1. Update all drawings and data required in the control submittal to a finalized form and add the following information:
 - a. An operator's manual which will include detailed instructions for all operations of the system. Include detailed instructions for accessing and using the graphical user interface.
 - b. A programmer's manual which will include all information necessary to perform programming functions.

- c. A language manual which will include a detailed description of the language used and all routines used by the system.
- d. An operator's reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
- e. Complete program listing file and parameter listing file for all programs.
- f. A copy of the warranty.
- g. Operating and maintenance cautions and instructions.
- h. Operation of Graphical User Interface.
- i. Recommended spare parts list.

3.11 TRAINING

- A. Contractor shall provide to the engineer a training class outline prior to any scheduled training.
- B. Training sessions shall be provided for the Owner's personnel by factory trained control engineers and technicians.
- C. The control contractor shall conduct four - four (4) hour on-site training sessions as a course for designated owner's personnel in the maintenance and operation of the control system. One course shall be given prior to system acceptance and one additional course shall be provided during the Warranty Support Plan period.
- D. The course shall include instruction on specific systems and instructions for operating the installed system on include as a minimum:
 1. HVAC system overview
 2. Operation of Control System
 3. Function of each Component
 4. System Operating Procedures
 5. Programming Procedures
 6. Maintenance Procedures

3.12 SPARES

- A. Provide one each of the following spare parts:
 1. Room Sensor
 2. Zone Controller Board (one of each type)
 3. Local Controller Board (one of each type)

3.13 EXPANSION

- A. System Controller Hardware and Software must be provided with expansion capabilities for the addition of control, points, etc. for future remodel of remainder of building.

END SECTION

**230993
 SEQUENCE OF OPERATIONS**

PART 1 GENERAL

SUMMARY:

- A. All HVAC Systems shall be controlled with Direct Digital Control (DDC) according to the point list contained in this specification. All controllers shall be capable of stand-alone operation and shall be interfaced to the system controller(s) and building graphical user interface. Additional points or software programming not listed in the point list but which are required to meet the specified sequences of operation shall be provided.

1.02 SUBMITTALS:

- A. See Section 23 0923 for submittal requirements specific to the temperature controls scope of work.

1.03 SETPOINTS:

- A. All setpoints shall be adjustable. All control loops shall utilize PI2 or PID control algorithms unless otherwise specified in the sequence of operation. Graphical interface shall be configured such that the deadband between zone heating and cooling setpoints cannot be less than 3°F.
- B. Occupied Zone Setpoints: Setpoints for occupied indoor zone temperatures shall be as follows, unless otherwise indicated. All zone setpoints shall individually adjustable through the BAS.

Occupied Zone Temperature and Humidity Setpoints							
Type	Heating	Cooling	Humidity	Type	Heating	Cooling	Humidity
Locker Rooms	70°F	75 °F	NA	Classrooms	70 °F	75 °F	N/A
Pool Equipment Room	69 °F	72 °F	N/A	Electrical Room	68 °F	73 °F	N/A

- C. Unoccupied Setpoints: Setpoints for unoccupied indoor zone temperatures shall be as follows, unless otherwise indicated. All zone setpoints shall individually adjustable through the BAS
 - 1. The heating night setback temperature shall be maintained at 65°F in the Unoccupied Mode and 70°F in the Morning Warm-Up mode.
 - 2. The cooling night setback temperature shall be maintained at 85°F in the Unoccupied Mode and 75°F in the Morning Cool-Down mode
- D. Occupancy Schedule
 - 1. The temperature controls contractor shall work with the owner to schedule occupied hours for all 365 days of the year including holidays.
 - 2. Pursuant to California 2019 Building Energy Efficiency Standards section 120.1(d).2 the building shall be scheduled as occupied at least 1-hour before the actual occupied use for a Pre-occupancy purge.

1.04 ALARMS:

- A. All zone controller, local controller, and system controller communication failures shall be capable of being annunciated at the system controller(s) and system graphical user interface as an alarm. All specified alarms shall be capable of being annunciated at the system controller(s) and system graphical user interface with alarm messages tailored for the specific alarm by system type and device type.

1.05 NORMAL POSITIONS:

1. Outside air damper - Closed
2. Return air damper - Open
3. Exhaust air damper - Closed

1.06 CONTROL SYSTEM KEY:

Symbol	Description
AUX	Auxiliary Contact
AQT	Air Quality Transmitter
CR	Control Relay
DM	Damper Motor
FA	Fire Alarm
FT	Flow Transmitter
FS	Flow Switch
FZ	Low Limit Thermostat
HOA	Hand/Off/Auto
IS	Current Switch
IT	Current Transmitter
PDT	Pressure Differential Transmitter
PDS	Pressure Differential Switch
PT	Pressure Transmitter
PS	Pressure Switch
SD	Smoke Detector
S/F	Smoke/Fire
S/S	Start/Stop
SC	Smoke Control
TS	Temperature Switch
TT	Temperature Transmitter
VFD	Variable Frequency Drive

1.07 POINTS LISTS:

- A. Refer to “Control Diagrams” on the construction drawings, for points lists.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 ENERGY RECOVERY UNIT CONTROL: 100% OA, CONSTANT VOLUME (ERV-1)

- A. Design Intent:
 1. This energy recovery packaged roof top unit will provide a constant volume of supply air for ventilation and temperature control purposes.
 2. The exhaust shall maintain constant volume of exhaust through restrooms and janitor closets during occupied hours.
 3. Outdoor air is pre-conditioned with an energy recovery wheel.
 4. Discharge air temperature control is provided by an air-source heat pump with back-up electric heating.
 5. VFDs will be used for fan balancing only.
- B. Safety Control:
 1. The outside air damper shall close when the fans stop.

2. An alarm shall be sent through the DDC system when the filter pressure reaches 1" w.c. (adj).
- C. Initial Starting Positions:
1. The scheduled occupied operation time is by the DDC system.
 2. Initial starting position of the rooftop unit supply fan and exhaust fan shall be off.
 3. When the supply and exhaust fans are off, the outside air dampers shall be closed, the exhaust damper shall be closed, the compressors shall be off and the heat shall be off.
 4. When a start is commanded, the dampers shall open and the supply and exhaust fans shall energize.
- D. Unoccupied Mode
1. The supply and exhaust fan cycles on calls for heating or cooling.
 2. The dampers are open when the fans are energized.
 3. Cooling is enabled when the space temperature is above the Occupied Cooling Setpoint plus the Unoccupied Cooling Offset and is disabled when the space temperature is one dead band below the Occupied Cooling Setpoint plus the Unoccupied Cooling Offset.
 4. Heating is enabled when the space temperature is below the Occupied Heating Setpoint minus the Unoccupied Heating Offset and is disabled when the space temperature is one dead band above the Occupied Heating Setpoint minus the Unoccupied Heating Offset.
 5. Cooling Mode: The supply fan VFD modulates to maintain the Space Temperature Setpoint while cooling modulates to maintain the Supply Air Cooling Setpoint.
 6. Heating Mode: The supply fan VFD modulates to maintain the Space Temperature Setpoint while heating modulates to maintain the Supply Air Heating Setpoint.
- E. Occupied Mode:
1. Supply fan control
 - a. The supply fan shall operate at a constant volume.
 2. Exhaust fan control
 - a. The exhaust fan shall operate at a constant volume.
 3. Discharge air temperature control:
 - a. The BAS shall send the active discharge air temperature setpoint to the unit's packaged controller.
 - b. The active discharge air temperature shall be maintained by the manufacturer's standard sequence.
 - 1) The air-source heat pump shall modulate to provide heating and cooling as required to meet the discharge air temperature setpoint.
 - 2) If the air-source heat pump cannot meet the discharge air temperature setpoint when heating is required, the back-up/auxiliary electric heat will be energized and modulated as required.
 - 3) The setpoint shall be varied based on the space temperature's deviation from setpoint.
 - c. The controls contractor shall reference the manufacturer's sequence in the controls shop drawings.

F. Heat Wheel

1. The heat wheel runs continuously in occupied mode unless economizer is enabled. The wheel is off and the outside air and exhaust air bypass dampers are open during economizer mode.
 2. Defrost mode slows the heat wheel speed when excessive wheel frost is detected. Once wheel frost reduces the heat wheel returns to full speed.
- G. Head Pressure Control
1. The condenser fans modulate to maintain the cooling head pressure setpoint.
 2. Dehumidification, the fans modulate to maintain the reheat head pressure setpoint.
- H. Alarm Detection and Reporting
1. Self-diagnostics determine if any failures have occurred.
 2. These failures (alarms) are reported to a Touch Screen System Manager, or a computer running Prism 2 software.
 3. Diagnostic LEDs on the controller generate “blink codes” for the following alarms:
 - a. Bad SAT Sensor
 - b. Bad RAT Sensor
 - c. Bad OAT Sensor
 - d. Bad Space Sensor
 - e. Missing Outdoor Airflow Sensor
 - f. Mechanical Cooling Failure
 - g. Mechanical Heating Failure
 - h. Fan Proving Alarm
 - i. Dirty Filter Alarm
 - j. Emergency Shutdown
 - k. No Economizer Feedback
 - l. Title 24 Economizer Air Temperature Sensor Failure
 - m. Title 24 Economizer Damper Failure
 - n. Title 24 Economizer Excess Outdoor Air
 - o. Title 24 Economizer Not Economizing When It Should
 - p. Title 24 Economizer Economizing, But Should not
 - q. High Supply Air Temperature Cutoff
 - r. Low Supply Air Temperature Cutoff
 - s. High Control Temperature
 - t. Low Control Temperature
 - u. Missing RSM#1
 - v. Missing RSM#2
 - w. Missing MHGRV-X Board
 - x. Missing EM1
 - y. RSM 1 Operating Alarm
 - z. RSM 2 Operating Alarm
- I. Sensor Failure Alarms
1. Bad Supply Air Sensor Alarm. If the supply air temperature sensor is not detected, an alarm is generated and the unit shuts down. If a sensor is detected after the unit has alarmed, the alarm is cleared and the unit restarts.
 2. Bad Space Temp Sensor Alarm. If the space sensor is not detected, an alarm is generated and the unit shuts down. Bad Outdoor Air Sensor Alarm. If the outdoor air temperature sensor is not detected, an alarm is generated and the outdoor air reading is set to halfway between the Cooling and Heating Lockout Setpoints to allow cooling and heating to continue.

3. Suction Pressure Sensor Failure Alarm. If the suction pressure sensor is not detected, an alarm is generated and the unit shuts down. If the sensor is detected after the unit has alarmed, the alarm is cleared and the unit restarts.
 4. Bad Outdoor Airflow Sensor Alarm. If the air flow sensor is not detected, an alarm is generated. If the sensor is detected after the unit has alarmed, the alarm is cleared.
 5. Missing Expansion Module Alarms. EM1 Expansion Board, Reheat Expansion Board ,RSM Modules missing alarms. If these expansion boards are not detected, the applicable alarm will occur. If the board is detected after the unit has alarmed, the alarm is cleared.
- J. Mechanical Failure Alarms
1. Mechanical Cooling Alarm. Supply air temperature fails to drop 5 °F (within an adjustable time period) from the temperature the supply air was at when the cooling was activated and the supply air temperature is not within 5 °F of setpoint. The alarm is cleared when the supply air temperature drops 5 °F and sets the failure timer back to zero. This alarm does not apply to modulating Cooling.
 2. Mechanical Heating Alarm. Supply air temperature fails to rise 5 °F (within an adjustable time period) from the temperature the supply air was at when the heating was activated and the supply air temperature is not within 5 °F of setpoint. The alarm is cleared when the supply air temperature rises 5 °F and sets the failure timer back to zero. This alarm does not apply to modulating heating.
 3. Fan Proving Alarm. An airflow switch closes when the supply fan is operating. If this contact opens while the fan is called to run, the unit shuts down and an alarm is generated.
 4. Dirty Filter Alarm. A differential pressure switch generates an alarm when the pressure drop exceeds the configured value.
 5. Emergency Shutdown Alarm. A 24 VAC wet contact monitors when a normally closed smoke detector or other shutdown condition occurs. If this contact opens, the unit stops and an alarm is generated.
- K. Failure Mode Alarms
1. High Supply Temp Cutoff Alarm. If the supply air temperature (SAT) is above the High Supply Temp Cutoff Alarm Setpoint, heating is immediately deactivated, the fan continues to run, and an alarm is generated until the mode is cancelled. The mode is cancelled when the SAT is 5 °F below the High Supply Temp Cutoff Alarm Setpoint.
 2. Low Supply Temp Cutoff Alarm. If the SAT is below the Low Supply Air Temp Cutoff Setpoint, mechanical cooling is immediately deactivated. If after 10 minutes the SAT is still below this setpoint, the unit shuts off and an alarm is generated until the mode is cancelled. The mode is cancelled when the SAT is 5 °F above the Low Supply Temp Cutoff Alarm Setpoint.
 3. High Control Temp Alarm. Space temperature rises above the Cooling Mode Enable Setpoint plus the Control Mode High Alarm Offset setpoint.
 4. Low Control Temp Alarm. Space temperature drops below the Heating Mode Enable Setpoint minus the Control Mode Low Alarm Offset setpoint.
- L. Points List:
1. Refer to drawings for points list and control diagrams.

3.02 VARIABLE VOLUME SINGLE ZONE ROOFTOP UNIT CONTROL (RTU-1)

- A. Design Intent:
 - 1. Packaged rooftop units are designed to provide heating, cooling and ventilation to a single zone.
 - 2. Each rooftop unit includes mixed air dampers, a power exhaust fan, exhaust air damper, air-source heat pump cooling / heating, electric back-up/auxiliary heating and a supply fan.
- B. General:
 - 1. The rooftop unit shall be enabled continuously during the occupied mode and shall be staged as necessary for unoccupied heating or morning warm-up.
 - 2. The rooftop unit shall have factory provided variable volume single zone controller with a DDC interface card. The DDC shall monitor and control the commercial rooftop unit in a stand-alone mode or as directed by the building automation system. Automation system to send control setpoints to the factory controller via the interface card as required to meet the below sequence of operations.
 - 3. The factory controller and building automation system shall perform the following rooftop control strategies, provide the points listed on the point list and provide the specified monitoring and diagnostics.
- C. Initial Starting Positions:
 - 1. The scheduled occupied operation time is by the DDC system.
 - 2. Initial starting position of the rooftop unit supply fan and exhaust fan shall be off.
 - 3. When the supply and exhaust fans are off, the outside air dampers shall be closed, the exhaust damper shall be closed, the return air damper shall be open, the DX compressors shall be off and the heat shall be off.
 - 4. When a start is commanded, the supply and exhaust fans shall energize and the outside air damper shall open to the occupied ventilation position.
- D. Building Management System (BMS) Integration
 - 1. The following control sequences shall be provided by the BMS and the appropriate values written to the RTU factory controller over BACnet MSTP.
 - 2. Occupied or Unoccupied Mode Selection
 - a. Enable Occupied Mode
 - b. Enable Unoccupied Mode
 - 3. Morning Warm-Up
 - a. The BMS monitors the space served by the unit and uses an optimal start routine to bring it to the occupied heating setpoint immediately prior to scheduled occupancy.
 - b. The unit should already be in unoccupied mode via the schedule.
 - c. Set the Unoccupied Heating Offset to 0.
 - d. When the occupied start time begins, enable Occupied Mode and return Heating Offset to its normal value.
 - 4. Morning Cool-Down
 - a. The BMS monitors the space served by the unit and uses an optimal start routine to bring it to the occupied cooling setpoint immediately prior to scheduled occupancy.
 - b. The unit should already be in unoccupied mode via the schedule.
 - c. Set the Unoccupied Cooling Offset to 0.

- d. When the occupied start time begins, enable Occupied Mode and return Cooling Offset to its normal value.
- E. Single Zone Variable Air Volume (VAV)
1. Space temperature and the Occupied Heating and Cooling Setpoints
 2. Occupied Mode
 - a. The supply fan runs continuously.
 - b. The outdoor air damper is at minimum position unless economizer is required.
 - c. Cooling is enabled when the space temperature is above the Occupied Cooling Setpoint plus the Mode Select Deadband and disabled when the space temperature is below the Occupied Cooling Setpoint minus the Mode Select Deadband.
 - d. Heating is enabled when the space temperature is below the Occupied Heating Setpoint minus the Mode Select Deadband and disabled when the space temperature is above the Occupied Heating Setpoint plus the Mode Select Deadband.
 - e. Cooling Mode: The supply fan modulates to maintain the space temperature setpoint while cooling modulates to maintain the Supply Air Cooling Setpoint.
 - f. Heating Mode: The supply fan modulates to maintain the space temperature setpoint while heating modulates to maintain the Supply Air Heating Setpoint.
 - g. Vent Mode: When the space setpoint is satisfied, the supply air setpoint is reset to the midpoint between the heating and cooling hood on enable temperatures to deliver neutrally tempered air to the space. In vent mode hood on cooling, the supply air temperature will not reset higher than a factory set maximum supply air temp setpoint to protect compressors from overheating (typically 65°F). The supply fan operates at Vent Mode Minimum VFD Setpoint.
 3. Unoccupied Mode
 - a. The supply fan cycles on calls for heating or cooling.
 - b. The outdoor air damper is closed unless economizer is required.
 - c. Cooling is enabled when the space temperature is above the Occupied Cooling Setpoint plus the Unoccupied Cooling Offset and is disabled when the space temperature is one dead band below the Occupied Cooling Setpoint plus the Unoccupied Cooling Offset.
 - d. Heating is enabled when the space temperature is below the Occupied Heating Setpoint minus the Unoccupied Heating Offset and is disabled when the space temperature is one dead band above the Occupied Heating Setpoint minus the Unoccupied Heating Offset.
 - e. Cooling Mode: The supply fan VFD modulates to maintain the Space Temperature Setpoint while cooling modulates to maintain the Supply Air Cooling Setpoint.
 - f. Heating Mode: The supply fan VFD modulates to maintain the Space Temperature Setpoint while heating modulates to maintain the Supply Air Heating Setpoint.
- F. Occupied or Unoccupied Mode Selection.
1. The BMS enables occupied or unoccupied mode over BACnet MSTP.
 2. Remote Forced Occupied Signal. Closing this wet contact input enables occupied mode. Opening this contact enables unoccupied mode.
 3. Forced Schedule. The unit can be forced into occupied mode through any operator interface (i.e. hand held, PC running Prism software).

G. Supply Fan Operation

1. When the supply fan is enabled, and a 1 minute min off timer is met, the supply fan is activated while the other outputs are held off until their minimum off timers are met.
2. When the unit is enabled, a fan starting delay can provide staggered start of multiple units.
3. When going into Occupied Mode, an adjustable length purge mode is initiated. The fan runs with the economizer closed, and heating and cooling are disabled.
4. When the supply fan is disabled, it is held on for 10 seconds after cooling has staged off or after leaving vent mode and 90 seconds after heating has staged off.
5. The supply fan VFD modulates to maintain the space temperature setpoint.

H. Exhaust Fan Operation

1. The exhaust fan operates at variable speed to control the building static pressure setpoint. Configure set point for 0.05" WC positive pressure.

I. Cooling

1. If the supply air temperature is above the Supply Air Cooling Setpoint plus the Cooling Staging Window, the compressors stage on and modulate to maintain the Supply Air Cooling Setpoint.
2. If the supply air temperature falls below the Supply Air Cooling Setpoint minus the Cooling Staging Window, cooling will begin to stage off.

J. Economizer

1. Economizer is enabled when the outdoor air dry bulb temperature is 1 °F below the Economizer Enable Setpoint and 5 °F below the return air temperature. Economizer is disabled when the outdoor air temperature is 1°F above the Economizer Enable setpoint.
2. Economizer is the 1st stage of cooling and controls to the Supply Air Cooling Setpoint. The economizer modulates between the Minimum Economizer Position and 100%. If the economizer is at 100% and the supply air temperature is above setpoint, mechanical cooling is enabled and the economizer is held at 100%. If cooling stages are currently running and economizer is enabled, it opens to 100%.
3. Economizer is at minimum position in heating and vent modes .

K. Heating

1. If the supply air temperature is below the Supply Air Heating Setpoint, the heat pump stages on and modulates to maintain the Supply Air Heating Setpoint. If additional heat is required, heat pump is held at 100% and the auxiliary heat will stage or modulate to maintain Supply Air Heating Setpoint. If the supply air temperature is below the Supply Air Heating Setpoint and the heat pump is not able to provide heating, the emergency electric stages on and modulates to maintain the Supply Air Heating Setpoint.
2. If the supply air temperature rises above the Supply Air Heating Setpoint plus the mod heating window (5 °F), heating will begin to stage off.

L. Vent

1. Enabled when there is no heating or cooling demand during occupied mode.
2. The fan will operate at the Minimum Main Fan VFD in Vent Mode Setpoint for single zone VAV units.

M. Outdoor Air Lockouts

1. Mechanical Cooling is disabled when the outdoor air temperature is below the Mechanical Cooling Outdoor Air Lockout. If the compressors are disabled while operating, cooling stages off as minimum run times and stage down delays are satisfied.
2. Heating is disabled when the outdoor air temperature is above the Mechanical Heating Outdoor Air Lockout Setpoint. If heating is disabled while operating, heating stages off as minimum run times and stage down delays are satisfied.
3. The compressors are disabled during heating mode when the outdoor air temperature is below the compressor heating lockout setpoint.

N. Supply Air Temperature Reset

1. The unit does not have supply air temperature reset.

O. Airflow Monitoring

1. Outdoor airflow is monitored with an airflow station.
2. The outdoor air damper modulates to maintain the Minimum Outdoor Air CFM Setpoint. This operation can be overridden higher by economizer control or lower by the demand controlled ventilation sequence.
3. The demand ventilation control sequence shall proportionately reset the outside air flow setpoint from the Minimum Ventilation airflow up to the Code Ventilation airflow in order to maintain a maximum space CO₂ concentration of 600ppm above the ambient CO₂ concentrations.
 - a. The TCC shall field install a zone CO₂ sensor and an outside air CO₂ sensor within 4'-0" of the unit's intake.
 - b. Ventilation rates are as indicated in the schedules.

P. Head Pressure Control

1. The condenser fans modulate to maintain the cooling head pressure setpoint.
2. Dehumidification, the fans modulate to maintain the reheat head pressure setpoint.

Q. Alarm Detection and Reporting

1. Self-diagnostics determine if any failures have occurred.
2. These failures (alarms) are reported to a Touch Screen System Manager, or a computer running Prism 2 software.
3. Diagnostic LEDs on the controller generate "blink codes" for the following alarms:
 - a. Bad SAT Sensor
 - b. Bad RAT Sensor
 - c. Bad OAT Sensor
 - d. Bad Space Sensor
 - e. Bad Building Pressure Sensor
 - f. Missing Outdoor Airflow Sensor
 - g. Mechanical Cooling Failure
 - h. Mechanical Heating Failure
 - i. Fan Proving Alarm
 - j. Dirty Filter Alarm
 - k. Emergency Shutdown
 - l. No Economizer Feedback
 - m. Title 24 Economizer Air Temperature Sensor Failure
 - n. Title 24 Economizer Damper Failure
 - o. Title 24 Economizer Excess Outdoor Air

- p. Title 24 Economizer Not Economizing When It Should
- q. Title 24 Economizer Economizing, But Should not
- r. High Supply Air Temperature Cutoff
- s. Low Supply Air Temperature Cutoff
- t. High Control Temperature
- u. Low Control Temperature
- v. Missing RSM#1
- w. Missing RSM#2
- x. Missing MHGRV-X Board
- y. Missing EM1
- z. RSM 1 Operating Alarm
- aa. RSM 2 Operating Alarm

R. Sensor Failure Alarms

1. Bad Supply Air Sensor Alarm. If the supply air temperature sensor is not detected, an alarm is generated and the unit shuts down. If a sensor is detected after the unit has alarmed, the alarm is cleared and the unit restarts.
2. Bad Space Temp Sensor Alarm. If the space sensor is not detected, an alarm is generated and the unit shuts down. Bad Outdoor Air Sensor Alarm. If the outdoor air temperature sensor is not detected, an alarm is generated and the outdoor air reading is set to halfway between the Cooling and Heating Lockout Setpoints to allow cooling and heating to continue.
3. Suction Pressure Sensor Failure Alarm. If the suction pressure sensor is not detected, an alarm is generated and the unit shuts down. If the sensor is detected after the unit has alarmed, the alarm is cleared and the unit restarts.
4. Bad Outdoor Airflow Sensor Alarm. If the air flow sensor is not detected, an alarm is generated. If the sensor is detected after the unit has alarmed, the alarm is cleared.
5. Missing Expansion Module Alarms. EM1 Expansion Board, Reheat Expansion Board ,RSM Modules missing alarms. If these expansion boards are not detected, the applicable alarm will occur. If the board is detected after the unit has alarmed, the alarm is cleared.

S. Mechanical Failure Alarms

1. Mechanical Cooling Alarm. Supply air temperature fails to drop 5 °F (within an adjustable time period) from the temperature the supply air was at when the cooling was activated and the supply air temperature is not within 5 °F of setpoint. The alarm is cleared when the supply air temperature drops 5 °F and sets the failure timer back to zero. This alarm does not apply to modulating Cooling.
2. Mechanical Heating Alarm. Supply air temperature fails to rise 5 °F (within an adjustable time period) from the temperature the supply air was at when the heating was activated and the supply air temperature is not within 5 °F of setpoint. The alarm is cleared when the supply air temperature rises 5 °F and sets the failure timer back to zero. This alarm does not apply to modulating heating.
3. Fan Proving Alarm. An airflow switch closes when the supply fan is operating. If this contact opens while the fan is called to run, the unit shuts down and an alarm is generated.
4. Dirty Filter Alarm. A differential pressure switch generates an alarm when the pressure drop exceeds the configured value.

5. Emergency Shutdown Alarm. A 24 VAC wet contact monitors when a normally closed smoke detector or other shutdown condition occurs. If this contact opens, the unit stops and an alarm is generated.

T. Failure Mode Alarms

1. High Supply Temp Cutoff Alarm. If the supply air temperature (SAT) is above the High Supply Temp Cutoff Alarm Setpoint, heating is immediately deactivated, the fan continues to run, and an alarm is generated until the mode is cancelled. The mode is cancelled when the SAT is 5 °F below the High Supply Temp Cutoff Alarm Setpoint.
2. Low Supply Temp Cutoff Alarm. If the SAT is below the Low Supply Air Temp Cutoff Setpoint, mechanical cooling is immediately deactivated. If after 10 minutes the SAT is still below this setpoint, the unit shuts off and an alarm is generated until the mode is cancelled. The mode is cancelled when the SAT is 5 °F above the Low Supply Temp Cutoff Alarm Setpoint.
3. High Control Temp Alarm. Space temperature rises above the Cooling Mode Enable Setpoint plus the Control Mode High Alarm Offset setpoint.
4. Low Control Temp Alarm. Space temperature drops below the Heating Mode Enable Setpoint minus the Control Mode Low Alarm Offset setpoint.

U. Title 24 Economizer Alarms (Economizer Fault Detection and Diagnostics)

1. Economizer Temperature Sensor Failure. Missing outdoor or supply air temperature sensor.
2. Not Economizing when it Should. Economizer enabled but not following the desired position.
3. Economizing when it Should Not. Economizer is not enabled but the feedback signal indicates a position more than the minimum.
4. Damper Not Modulating. Economizer enabled but not at 10% of desired position in 150 seconds.
5. Excess Outdoor Air. Economizer feedback is lost or not following commanded position.

3.03 POOL MECHANICAL AND BUILDING MECHANICAL ROOM MAKE-UP AIR UNIT AND SPACE PRESSURE CONTROL SEQUENCE (MAU-1, EF-6)

A. Design Intent

1. The make-up air unit shall provide ventilation, heating and cooling to the pool equipment room.
2. The pool equipment room exhaust fan maintains a slight positive pressure in the pool equipment room.
3. The make-up air unit includes a supply fan, heat pump heating and cooling system with back-up natural gas heating.

B. General

1. The make-up air unit shall be provided with factory controls and a BACnet interface for limited control by the BAS.
2. The BAS shall send fan speed and discharge air temperature setpoints to the packaged controller.

3. The make-up air unit and pool equipment room exhaust fan shall operate continuously 24/7/365 to ensure adequate ventilation in the pool equipment room.

C. Sequence of Operations

1. Initial starting positions and sequence:
 - a. Equipment shall operate continuously 24/7/365.
 - b. If the make-up air unit is to be disabled the outside air damper shall close. When a start is commanded the make-up air unit outside air damper shall open and the fan shall start.
2. Occupied control:
 - a. The BAS shall send the packaged controller an active discharge air temperature based on the space temperature's deviation from the space setpoint.
 - 1) Minimum DAT setpoint = 55°F
 - 2) Maximum DAT setpoint = 90°F.
 - b. The unit's packaged controls shall modulate the heating and cooling to maintain the active discharge air temperature setpoint.
 - c. The heat pump heating shall be disabled (by the packaged controller) whenever the ambient lockout temperature is reached (40°F, adj.)
 - d. The unit shall be disabled and alarm sent if the discharge air temperature drops below the minimum setpoint (50°F, adj.)
 - e. The BAS shall send a supply fan speed to the packaged controller based on the following sequence:
 - 1) Heating:
 - a) Upon a call for heating the heat pump shall modulate to maintain the active discharge air temperature setpoint
 - b) Natural gas heating shall be enabled whenever the ambient temperature lockout is reached.
 - c) The fan speed shall remain at the balanced speed corresponding to the scheduled minimum airflow.
 - 2) Cooling:
 - a) Upon a call for cooling the heat pump shall modulate to maintain the active discharge air temperature setpoint.
 - b) The fan speed shall remain at the balanced speed corresponding to the scheduled maximum airflow.
3. Zone pressure control: The exhaust fan, EF-6, shall modulate speed maintain the pool equipment room pressure .01" w.c above the outdoor pressure.

D. Safeties:

- a. The outside air damper shall close when the fan stops for any reason.
- b. A software low limit discharge air temperature shall stop the fan, close the outside air damper and alarm the DDC should the DAT temperature drop below 40°F.

3.04 FAN CONTROL

A. Design Intent:

1. Miscellaneous exhaust fans and transfer air fans are designed to provide ventilation for various purposes. Fans provide code required exhaust ventilation, temperature control or general exhaust for space served.
2. High volume low speed (HVLS) fans are designed to provide de-stratification of the space during heating season and passive cooling during the cooling season.

B. General:

1. Exhaust and transfer fans shall be controlled and/or monitored as specified per the following control sequences. DDC shall monitor status of all fans noted in this section. Interface fans to nearest available local DDC controller or zone controller. At contractor's option where nearest available controller is far away, provided a dedicated controller for the associated fan(s).
2. Initial starting position of DDC controlled exhaust and transfer air fans shall be off.

C. Fan Sequences of Operations.

1. EF-1: Fan shall be provided with a dedicated 12-hour timer switch.
2. EF-2,5: Fan shall be controlled by the occupied/unoccupied schedule through the building automation system. Fans shall energize continuously during the occupied mode
3. EF-3,4: Fan shall operate via the lighting occupancy sensor by Div 26.
4. EF-6: Refer to POOL MECHANICAL AND BUILDING MECHANICAL ROOM MAKE-UP AIR UNIT AND SPACE PRESSURE CONTROL SEQUENCE.
5. EF-7,8: The fans shall run continuously 24/7/365. Provide a current sensing device which shall initiate an alarm through the BAS upon failure of the fan and activate the fan failure light. See detail for fan failure light.

3.05 MISCELLANEOUS DDC CONTROL

- A. Domestic Hot Water Circulation Pump (PP-1 & PP-2): The pump shall be controlled by the occupied/unoccupied schedule through the building automation system. Monitor status and sound alarm through DDC system upon pump failure.
- B. Sewage Ejector Pumps (SE-1 & SE-2): Pumps shall operate through their own integral control system. Sound alarm through DDC system via the pumps' control panel's dry contact alarm pick up.
- C. Sump Pump Pumps (SP-1 & SP-2): Pumps shall operate through their own integral control system. Sound alarm through DDC system via the pumps' control panel's dry contact alarm pick up
- D. Pool System Controller: Provide a general alarm to the building automation system through auxiliary contacts provided by the controller manufacturer.
 1. This alarm is dependent on the successful pool controller manufacturer. Coordinate at the time of shop drawing submittals.

E. Ductless split system air conditioners

1. Ductless split air conditioners shall be controlled by a manufacturer's hardwire thermostat. The BAS shall control system status, space temperature setpoint and monitor system status, mode of operation, fan speed and room temperature via a manufacturer provided BACnet MS/TP module.
2. Alarm the BAS if the space temperature exceeds setpoint by 5°F (adj.) for 10 (adj.) consecutive minutes.

F. Water Feeder Monitoring

1. Monitor the water feeder water level and alarm the BAS upon detecting low water level.

3.06 MISCELLANEOUS NON-DDC CONTROL

A. Unit Heater Control (Electric):

1. Provide a manufacturer's temperature sensor to cycle fan motor and energize the electric heat to maintain constant space temperature.

END SECTION

232300

REFRIGERANT PIPING SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 23 2000: HVAC Pipes, Valves and Piping Specialties.

1.02 DESCRIPTION OF WORK

- A. Types of equipment specified within this section include the following:
 1. Refrigerant Piping & Specialties.
 2. Refrigerant Valves.
 3. Ductless Split System.
 4. Condensate Pump.

1.03 SUBMITTALS

- A. See Section 01 3000 – Administrative Requirements, for submittal procedures.
- B. Provide the following submittals:
 1. Refrigerant Piping & Specialties.
 2. Refrigerant Valves.
 3. Ductless Split System.
 4. Condensate Pump.
- C. Shop Drawings: Submit manufacturer approved and signed drawings of refrigerant pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between piping and proximate equipment.

1.04 REGULATIONS

- A. Refrigeration systems or appliances shall:
 1. Be equipped with a fully protected and isolatable receiver or condenser of sufficient capacity to hold the complete refrigerant charge during servicing or repairs. This requirement shall apply only to systems and appliances with 50 pounds or greater of the manufacturer's recommended/estimated charge. However, refrigeration systems with less than 50 pounds capacity shall be equipped with suitable access valve(s) in order to provide for recovery of refrigerant charge if necessary.
 2. Be equipped with a system of relief valves, including reseatable relief valve and non-fragmenting disk, designed to automatically reseal after activation, to minimize refrigerant losses in the case of equipment breakdown or failure.
 3. Be installed meeting, at a minimum, the applicable requirements set forth in the ASHRAE Guideline 15-2007.

PART 2 PRODUCTS

2.01 MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with ANSI B31.5 Code for Refrigeration Piping where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems.

2.02 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings complying with Division 23, Section 23 2000.

2.03 SPECIAL REFRIGERANT VALVES

- A. General: Special valves required for refrigerant piping include the following types:
- B. Globe and Check Valves:
 - 1. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300°F (149°C) temperature rating, 500 psi working pressure.
 - 2. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless-steel spring, 250°F (121°C) temperature rating, 500 psi working pressure.
 - 3. Acceptable Manufacturers:
 - a. Henry Valve Co.
 - b. Sporlan Valve Co.
- C. Solenoid Valves:
 - 1. 2-Way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, Teflon valve seat, NEMA 1 solenoid enclosure, 24-volt, 60 Hz., UL-listed, 1/2" conduit adapter, 250°F (121°C) temperature rating, 400 psi working pressure.
 - 2. Manual Operator: Provide manual operator to open valve.
 - 3. Acceptable Manufacturers:
 - a. Alco Controls Div.; Emerson Electric Co.
 - b. Automatic Switch Co.
 - c. Sporlan Valve Co.
- D. Thermal Expansion Valves: Shall be sized and selected per equipment manufacturers recommendation.
 - 1. Acceptable Manufacturers:
 - a. Alco Controls Div.
 - b. Henry Valve Co.
 - c. Sporlan Valve Co.

2.04 REFRIGERANT SPECIALTIES

- A. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL-listed, 350 psi working pressure.
- B. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL-listed, 200°F (93°C) temperature rating, 500 psi working pressure.
- C. Refrigerant Filter-Driers: Steel shell, ceramic fired desiccant core, solder connections, UL-listed, 500 psi working pressure.
- D. Refrigerant Filter-Driers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron cover plate with steel cap screws, replaceable filter-drier core, 500 psi working pressure.
- E. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.
- F. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL-listed.
- G. Acceptable Manufacturers:
 - 1. Alco Controls Div.; Emerson Electric Co.
 - 2. Henry Valve Co.

3. Sporlan Valve Co.

2.05 SPLIT SYSTEM HEAT PUMPS

A. General:

1. Furnish & install a Ductless, Split System Heat Pump, consisting of an indoor, high wall mounted fan coil section & matching outdoor heat pump.
2. System shall bear the ARI label showing that the system is ARI certified.
3. System shall meet or exceed the minimum, Seasonal Energy Efficiency Rating (SEER) of 13 or better as certified by the ARI testing programs.
4. System indoor & outdoor units shall operate at sound levels equal to or below the specified system.
5. Installation & Owners Manuals shall be provided with each system.
6. Matching indoor & outdoor sections shall be connected by deoxidized, annealed refrigerant copper tubing, type "L", cleaned & capped. All systems shall have flared refrigeration connections on both indoor & outdoor sections. Size & insulate tubing according to manufacturer's specifications.
7. System indoor & outdoor sections shall be completely factory assembled & wired, with a precharge of refrigerant.
8. A single power source shall provide voltage to both the outdoor & indoor units.
9. Electrical wire & connections to outdoor section, and between indoor & outdoor section, shall be sized, installed & grounded by the installer in conformance with the National Electrical Code (N.E.C.), local codes, as well as, manufacturer's instructions.
10. System shall be equipped with a microprocessor control system.
11. System shall include the following:
 - a. High efficiency, rotary compressor.
 - b. Cap tube refrigerant control.
 - c. Indoor coil freeze protection.
 - d. Built-in auto restart after power failure.
 - e. Short cycle time delay.
 - f. Automatic indoor fan speed determined by the system microprocessor.
 - g. Dehumidification mode.
 - h. Washable anti-mold poly filters.
 - i. Indoor mounted operation selector & lamp showing operation, standby & timer modes, with startup test mode & manual on/off switch.

B. Outdoor Heat Pump

1. Outdoor heat pump shall be factory assembled, wired, piped & pre-charged with a start up amount of R-410A refrigerant.
2. Unit shall be constructed of G90 galvanized steel with corrosion inhibiting, powder coated paint.
3. Unit shall be furnished with a high efficiency, scroll compressor with internal overload protection, securely mounted with vibration isolators to reduce noise & vibration.
4. Condenser coil heat exchanger shall be constructed of nonferrous, rifled copper tubing with enhanced aluminum slit fins mechanically bonded to the copper.
5. A suction line accumulator, a coil temperature sensor and cap tube metering device shall be factory installed.
6. Fan motor shall be direct drive with internal overload protection, permanent lubrication, with propeller type fans, mounted for horizontal air discharge.
7. Brass valves with refrigeration flare connections & flare nuts, & service ports shall be factory mounted, externally for easy access.
8. The unit shall be test started by the manufacturer at their factory prior to shipment for installation.
9. Low Ambient Controls:
 - a. Outdoor unit shall contain a printed circuit board with a sequencer, factory mounted & wired, to assist in control of low ambient operation.

- b. Unit shall be able to operate in the A/C mode down to -10 degrees Fahrenheit outdoor temperature.
- C. Indoor Evaporator Section
1. Indoor section(s) shall be high wall mount type, factory assembled & wired.
 2. Wall mounting fixture, plate & mounting diagram shall be included with each system, as well as wall sleeves to protect wall where tubing passes through.
 3. Unit shall contain an evaporator coil heat exchanger constructed of nonferrous, rifled copper tubing with enhanced aluminum slit fins, mechanically bonded to the copper.
 4. A single cross-flow blower wheel, statically & dynamically balanced shall be attached to a single direct drive, PSC fan motor, with overload protection, permanent lubrication & multi-speed capability.
 5. Unit shall contain a Printed Circuit Board (PCB) with a control circuit fuse & microprocessor, factory wired & mounted, that receives & processes all commands & transmissions from the system Controller.
 6. Indoor unit shall contain an Operation Switch with visible lamps for operation, standby & timer functions, as well as, a system test switch & a manual ON/OFF switch.
 7. Unit shall contain a room sensor thermistor, a coil temperature safety thermistor to prevent freeze-up in the A/C mode, a factory installed condensate drain pan, drain hose & fitting, and refrigeration line connections with flare nuts.
 8. Unit shall contain knockouts on both sides of the casing that allow refrigerant lines to be brought to the unit from multiple directions.
 9. A motorized louver/flap, controlled by the unit controller, shall provide automatic, full oscillating supply airflow, as well as being capable of being placed in a set, stationary position.
 10. Unit shall also contain adjustable, horizontal air louvers to provide user defined, directional airflow.
 11. Unit shall be provided with anti-mold, poly type washable air filters that can be easily removed without removing indoor unit casing.
 12. Indoor unit shall be powered by voltage from the matching outdoor unit.
- D. Unit Accessories:
1. Provide the following accessories with the split system unit:
 2. Insulated Copper Line Set
 3. Condensate Pump
 4. Hail Guards: Provide manufacturer's coil guard for condenser coil protection.
- E. Acceptable Manufacturers:
1. Sanyo.
 2. Mitsubishi.
 3. Daikin.

2.06 CONDENSATE PUMP

- A. Provide condensate pumps for removal of condensate where required for condensate lift from air conditioning equipment and as indicated on the drawings.
- B. Condensate pumps at a minimum shall include the following features. Increase capacities as required for equipment served but size no smaller than below.
 1. 1/50 hp high performance motor.
 2. ABS condensate reservoir tank, motor cover and volute.
 3. Integral condensate reservoir tank (minimum).
 4. Stainless seal pump shaft.
 5. Snap action float switch.
 6. Integral check valve.
 7. Three inlet drain holes.
 8. Thermal overload protection.

9. Overflow / pump failure switch.
10. Plenum rated for ceiling application.
11. 120/1 power, hard wired for above ceiling applications, 3-conductor cable with grounded 3-prong plug for floor mounted or exposed applications.

C. Acceptable Manufacturers

1. Little Giant Model VCC-20-P (above ceiling applications) Model VCC-20 (floor mounted or exposed applications)
2. Liberty

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which refrigerant systems and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF REFRIGERANT PIPING

- A. Install refrigerant piping with 1/4" per foot (1%) downward slope in direction of oil return to compressor. Provide oil traps and double risers where indicated, and where required to provide oil return.
- B. Clean refrigerant piping by swabbing with dry lintless (linen) cloth, followed by refrigerant oil-soaked swab. Remove excess oil by swabbing with cloth soaked in high flash point petroleum solvent, squeezed dry.
- C. Bleed dry nitrogen through refrigerant piping during brazing operations.
- D. Refer to Section 23 2000 for Hanger and Support requirements.

3.03 INSTALLATION OF SPECIAL REFRIGERANT VALVES

- A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions. Remove accessible internal parts before soldering or brazing, replace after joints are completed:
 1. Solenoid Valves: Install in refrigerant piping as indicated with stem pointing upwards.

3.04 INSTALLATION OF REFRIGERANT ACCESSORIES

- A. Refrigerant Strainers: Install in refrigerant lines as indicated, and in accessible location for service.
- B. Moisture-Liquid Indicators: Install as indicated on refrigerant liquid lines, in accessible location.
- C. Refrigerant Filter-Dryers: Install in refrigerant lines as indicated, and in accessible location for service.
- D. Evaporator Pressure Regulators: Install in refrigerant suction lines or evaporator outlets as indicated. Adjust, if required, for proper evaporator pressure.
- E. Refrigerant Discharge Line Mufflers: Install as indicated, in horizontal or downflow portion of hot-gas lines, immediately after leaving compressor; not in riser.

3.05 EQUIPMENT CONNECTION

- A. General: Connect refrigerant piping to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.06 FIELD QUALITY CONTROL

- A. Refrigerant Piping Leak Test: Prior to initial operation, clean and test refrigerant piping in accordance with ANSI B31.5, "Refrigeration Piping". Perform first test with dry nitrogen, using soap solution to test all joints. Perform second test as follows: fill system with 20 psi refrigerant and then charge to 480 psi (R-410A) with nitrogen. Let stand 24 hours and check to see that the charge has held. Check all joints with a halide leak detector. Perform final test by pulling a 2 mm Hg vacuum. The system must hold this vacuum for a period of 24 hours. System must be entirely leak-free.
- B. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

3.07 INSTALLATION OF SPLIT SYSTEM AIR CONDITIONING UNITS

- A. General: Install split system air conditioning units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
- B. Support: Install roof-mounted split system air conditioning unit as indicated on drawings. Coordinate setting and support of unit with General Contractor prior to installation.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- D. Distance between indoor & outdoor unit(s) shall not exceed manufacturer's specifications.
- E. Refrigerant tubing size shall not vary from manufacturer's specifications, and shall be properly secured & insulated.
- F. Installer shall insulate both liquid & suction lines individually.
- G. Outdoor condenser shall be mounted & secured to accommodate for extreme weather conditions.
- H. System shall be mounted & placed as shown on plans within all minimum clearances as specified by manufacturer's instructions, & secured to provide for safe operation.

3.08 INSTALLATION OF CONDENSATE PUMPS

- A. Provide pumps on indoor air conditioning equipment where required for condensate removal lift and as specified on the drawings.
- B. Pipe condensate pump discharge from pump outlet vertically as high as possible then offset piping to gravity drain. Piping from pump shall be minimum 3/4" copper piping, provide maximum 1'-0" of factory provided 3/8" poly tubing from pump outlet then transition to 3/4" copper drain piping. Poly tubing shall be installed free of any kinks or drops that would create a water "trap".
- C. Piping from air conditioning unit drain pan to condensate pump shall be minimum 3/4" copper piping.
- D. Where required for wall mounted units provide wall support for mounting of condensate pump against wall below the wall mounted indoor unit.
- E. Wire condensate pump factory safety switch to indoor air conditioning equipment. Switch shall shut off associated equipment upon pump failure or condensate overflow.

3.09 FIELD QUALITY CONTROL

- A. Testing: Upon completion of installation of split system air conditioning units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.

3.10 EXTRA STOCK

- A. Provide one complete extra set of filters for each split system air conditioning units. Install new filters at completion of split system air conditioning unit work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.

END SECTION

233000
AIR DISTRIBUTION

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Types of equipment specified in this section include the following:
 - 1. Metal Ductwork.
 - 2. Ductwork Accessories.
 - 3. Grilles, Registers & Diffusers.
 - 4. Dampers.
 - 5. Fans.

1.02 SUBMITTALS

- A. Provide the following submittals:
 - 1. Rectangular metal ductwork
 - 2. Round and flat oval metal ductwork
 - 3. Duct taps and fittings
 - 4. Duct liner
 - 5. Duct sealant and cement
 - 6. Duct supports
 - 7. Flexible ductwork
 - 8. Dampers
 - 9. Fire Dampers
 - 10. Duct Accessories: Quadrant locks, access doors, turning vanes, flexible connections
 - 11. Grilles, Registers, and Diffusers
 - 12. Fans
- B. Submit scaled layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, access doors and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.
- C. Within 30 days after award of contract, submit a shop drawing for approval to the structural engineer showing size and location of all openings through roofs and structural members. Do not proceed until the shop drawing has been reviewed, approved and returned.

1.03 TEST AND BALANCE COORDINATION

- A. Prior to starting work, the contract documents shall be given to the Test and Balance contractor for his review. If there are any areas of the air distribution system that cannot be balanced, due to the configuration of the system, a Request for Clarification shall be made in a timely manner to allow revisions to the documents before the systems are installed.

PART 2 PRODUCTS

2.01 DUCTWORK

- A. Material:
 - 1. Galvanized Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel CS-B, lock forming quality; with G 90 zinc coating in accordance with ASTM A 653; and mill phosphatized for exposed locations.

B. Rectangular Duct:

1. Construct rectangular ductwork to meet all functional criteria defined in Section 11, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 2005 Edition. All ductwork must comply with all local, state and federal code requirements.
2. Where the standard allows the choice of external reinforcing or internal tie rods, only the external reinforcing options shall be used.
3. All longitudinal seams will be sealed with mastic sealant.
4. Formed on flanges (T.D.C./T.D.F./T-25A/T-25B) shall be constructed as SMACNA T-25 flanges, whose limits are defined on Page 2.76 2005 SMACNA Manual, Third Edition. No other construction pertaining to formed on flanges, will be accepted.
5. At contractor option, Ductmate or W.D.C.I. proprietary duct connection systems will be accepted. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.
6. Ductmate type systems that use a butyl Rubber Gasket which meets Mil-C 18969B, Type II Class B, TT-C-1796 A, Type II Class B, and TTS-S-001657 must also pass UL-723. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth (as defined in 21CFR 177, 1210 closures with sealing gaskets for food containers).
7. Aluminum duct shall be fabricated using the aluminum thickness equivalence table in the standard. Simply increasing the thickness by two gauges is not acceptable.
8. Fittings shall be constructed and reinforced as ductwork according to the longest span.

C. Round and Flat-Oval Duct:

1. Round and oval duct shall be galvanized steel, constructed in accordance with Section 11 of the 2005 SMACNA "Duct Construction Standards, Metal and Flexible", except as noted.
2. Application
 - a. All round and oval ductwork shall be spiral.
 - b. Snaplock ductwork will be allowed for low-pressure, concealed ductwork up to 12" diameter only.
 - c. Minimum duct gauge shall be 26 gauge.
3. Snaplock Ductwork with self-locking, pre-sealed longitudinal seams. Ductwork shall incorporate a factory applied gasket in the longitudinal seam and female ends at transverse joints. Gauges shall be in accordance with SMACNA Duct Construction Standard and fittings in accordance with SMACNA Duct Construction Standard.
4. Spiral Round Ductwork: Gauges shall be in accordance with SMACNA Duct Construction Standard and fittings in accordance with SMACNA Duct Construction Standard, except as noted:
 - a. Joints 0"-10" diameter, interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening. Wrap joints with 3-inch wide duct tape.
 - b. Joints 12"-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. Example: Ductmate Spiralmate or equal.
5. Fittings shall be continuously welded, standing seam, or spot welded and sealed. Metal thickness and reinforcing shall be equivalent to the requirements of the largest span.
 - a. All elbows greater than 45° shall be radius type, R=1.5 times duct diameter.
 - b. Elbows less than 6" shall be of die stamped construction. Elbows 6" or greater shall be 5-gore construction.
 - c. Diverging and converging flow fittings shall be constructed with no excess material projecting from the body into the branch tap entrance. All such fittings shall be 45° "shoe" entrance, wye plus elbow, or 45° lateral branch. Special fittings such as heel tapped elbows and bullhead tees may be used only where shown on drawings. Adjustable elbows and straight saddle taps shall not be used. Low pressure adjustable elbows acceptable.

- D. Round Duct Taps
 - 1. Conical: Bellmouth spin-in fittings shall be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles) even though a volume damper may be specified for the air device. (This does not apply for high pressure duct). The spin collar fitting shall be made from G-90 galvanized sheet metal. The construction shall have a fabricated minimum overall length of 7". The location of spin-in fittings in the ducts shall be determined after terminals are hung or the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends.
 - 2. High Efficiency Take-off (HETO): rectangular opening with integral, tapered rectangular to round transition and approximate 45° slope on body. Flange mount with gasket to duct main. Provide with damper as indicated on plans, with low-leakage hardware and closed-end bearings, with standoff for external insulation as required. Material and thickness to match duct main, minimum thickness of 26-gauge steel.

2.02 DUCTWORK FABRICATION

- A. Shop fabricate ductwork of gauges and reinforcement complying with SMACNA "HVAC Duct Construction Standards".
- B. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with centerline radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.
- C. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.
- D. Factory Fabricated: At installer's option, provide factory-fabricated duct and fittings, in lieu of shop-fabricated duct and fittings. Factory fabricated duct shall not be less than 26 gauge and shall be constructed according to SMACNA standards.
- E. Duct Construction Schedule:

DUCT CONSTRUCTION SCHEDULE					
System	SMACNA Duct Class	SMACNA Seal Class	Duct Test Pressure (P)	Leakage Class (C_L) (Rect. / Round)	Quantity Tested (Note: 1)
Supply and Return Air Duct Mains	2"	C	2"	24 / 12	None
Return and Exhaust Air Duct Branches to GRDs	1"	C	1"	24 / 12	None
Notes:					
1. Amount of duct tested is a percentage of total square feet of ductwork for the indicated system. Contractor shall test sections of duct to meet total area as indicated.					
2. Ductwork leakage (F) shall be calculated from the following equation, per SMACNA Duct Leakage Test Manual: $F = CL \times P(0.65)$					
3. Provide test reports per SMACNA Duct Leakage Test Manual for each section of duct tested.					

2.03 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.
- C. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15-degree change of direction per section. Unless specifically detailed otherwise, use 45-degree laterals and 45-degree elbows for branch takeoff connections. Where 90-degree branches are indicated, provide conical type tees.
- D. Duct Liner: Fibrous glass, complying with Thermal Insulation Manufacturers Association (TIMA) AHC-101; of 1" thick. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B. The 1" duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than .70 and a thermal conductivity no higher than .25 at 75°F mean temperature. The surface coating shall contain an immobilized EPA registered anti-microbial agent as tested in accordance with ASTM-G-21 and 423 "Type A Mountain." Shop or field cut insulation shall be coated with a sealant approved for use in duct systems.
- E. Round Duct Liner: Fibrous glass, complying with Thermal Insulation Manufacturers Association (TIMA) AHC-101; of 1" thick. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B. The 1" duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than .70 and a thermal conductivity no higher than .25 at a 75°F mean temperature. The surface coating shall contain an immobilized EPA registered anti-microbial agent as tested in accordance with ASTM-G-21 and 423 "Type A Mountain." Shop or field cut insulation shall be coated with a sealant approved for use in duct systems. The liner shall be provided with factory-made, evenly spaced kerfs to allow the material to conform to the inside diameter of round air ducts.
- F. Duct Sealant: Non-hardening, non-migrating mastic or liquid elastic sealant, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.
 - 1. VOC content not to exceed 250 g/L.
- G. Duct Cement: Non-hardening migrating mastic or liquid neoprene-based cement, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
- H. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - 1. VOC content not to exceed 30 g/L.
 - 2. Except where space is indicated as "High Humidity" area, interior support materials of not less than 1/4" diameter or 3/16" thickness may be plain (not galvanized).
- I. Flexible Ductwork:
 - 1. Low Pressure Flexible Ducts: Duct shall be factory pre-insulated with a solid inner liner formed by a reinforced aluminum laminate material mechanically locked or bonded together by a corrosive resistant galvanized steel helix, covered with a minimum 1-1/2" thick fiberglass blanket and sheathed in a polyethylene vapor barrier. The insulation shall have a maximum 0.23 "C" factor, to meet FHA/HUD requirements and a vapor barrier permeability

of 0.10 perms (ASTM E96-Procedure A). The duct shall have a positive working pressure rating of 6" w.g. (all diameters), negative working pressure rating of 1" w.g. (all diameters) and at a maximum operating temperature of 180°F (all diameters). Pressure rating based on test with temperature and velocity applied. The duct shall comply with the latest NFPA 90A Bulletin and be UL-181 listed as a Class I Air Duct.

2. Acceptable Manufacturers:
 - a. Flexmaster.
 - b. Glenflex.
 - c. Thermaflex.

2.04 DAMPERS

- A. Low Pressure Balancing Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards".
- B. Counterbalanced Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 16-gauge aluminum, provide 1/2" diameter ball bearings, 1/2" diameter steel axles spaced on 9" centers. Construct frame of 2" x 1/2" x 1/8" steel channel for face areas 25 sq. ft. and under; 4" x 1-1/4" x 16-gauge channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up.
- C. Acceptable Manufacturers:
 1. Greenheck
 2. Penn Ventilator Co.
 3. Pottorff.
 4. Ruskin Mfg. Co.

2.05 FIRE DAMPERS

- A. General: Provide fire dynamic type dampers, of sizes and types indicated. Dampers shall be constructed and tested in accordance with the current edition of UL-555 Standard for Fire Dampers. Provide fusible link rated at temperature indicated. Dampers marked "for use in static systems only" are not permitted. Submittal information shall include the fire protection rating, maximum velocity/pressure ratings and the manufacturer's UL installation instructions. The dampers shall be installed in accordance with these instructions.
- B. Ratings:
 1. Fire Rating: 1-1/2 hour in accordance with UL-555
 2. Temperature Release Rating: 165°F.
 3. Airflow rating: 2,000 FPM minimum
 4. Differential Pressure Rating: 4 in. w.g
- C. Curtain Style Dampers
 1. Duct sizes: Ductwork up to 20" in height.
 2. Frame: 316 stainless steel.
 3. Blades: 316 stainless steel, curtain type.
 4. Style: Type "A", blades in airstream.
 5. Duct connection: Provide rectangular, round, or oval connections as required for each damper to connect to ductwork as shown on plans.
- D. Accessories:
 1. Factory sleeve.
 2. Mounting angles as required for installation.
 3. Breakaway connection.

- E. Acceptable Manufacturers:
 - 1. Greenheck.
 - 2. Pottorff.
 - 3. Prefco.
 - 4. Ruskin Mfg. Co.

2.06 TURNING VANES

- A. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2" wide single wall curved blades set at 3/4" o.c.; supported with bars perpendicular to blades set at 2" o.c.; and set into side strips suitable for mounting in ductwork.
- B. Acceptable Manufacturers:
 - 1. Aero Dyne Co.
 - 2. Airsan Corp.
 - 3. Anemostat Products Div.; Dynamics Corp. of America.
 - 4. Barber-Colman Co.
 - 5. Duro Dyne Corp.
 - 6. Titus Products Division, Phillips Industries, Inc.
 - 7. Hercules Industries.

2.07 QUADRANT LOCKS

- A. Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
- B. Acceptable Manufacturers:
 - 1. Ventfabrics, Inc.
 - 2. Young Regulator Co.

2.08 DUCT ACCESS DOORS

- A. General: Provide duct access doors of size required.
- B. Construction: Construct of same or greater gauge as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors. Provide 12 x 12 for hand access and 24 x 24 for head and shoulder access.
- C. Acceptable Manufacturers:
 - 1. Air Balance Inc.
 - 2. Duro Dyne Corp.
 - 3. Pottorff.
 - 4. Ruskin Mfg. Co.
 - 5. Ventfabrics, Inc.

2.09 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

- B. Acceptable Manufacturers:
 - 1. American/Elgen Co.; Energy Div.
 - 2. Duro Dyne Corp.
 - 3. Flexaust (The) Co.
 - 4. Ventfabrics, Inc.

2.10 GRILLES, REGISTERS AND DIFFUSERS

- A. General: Except as otherwise indicated, provide manufacturer's standard air device where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide air devices that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling/Wall Compatibility: Provide air devices with border styles that are compatible with adjacent ceiling/wall systems, and that are specifically manufactured to fit into ceiling/wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling/wall construction which will contain each type of air device.
- D. Types: Provide air device of type, capacity, and with accessories and finishes as listed on grilles, register and diffuser schedule.
- E. Acceptable Manufacturers:
 - 1. Krueger Mfg. Co.
 - 2. Price.
 - 3. Titus Products Div.; Philips Industries, Inc.
 - 4. Air Concepts

2.11 CENTRIFUGAL ROOF VENTILATORS

- A. General: Provide AMCA certified centrifugal roof type, curb mounted, power ventilators of type, size, and capacity as scheduled, and as specified herein.
- B. Type: Centrifugal fan, direct or belt driven as scheduled. Provide aluminum, galvanized or steel weatherproof housings as scheduled. Provide square base to suit roof curb. Provide motor and drive type as scheduled and as specified herein.
 - 1. Housing Design: Hooded dome type.
- C. Wheel: Provide non-overloading backward inclined centrifugal wheel. Wheel shall be constructed of aluminum, galvanized or steel as scheduled. Wheel shall be statically and dynamically balanced in accordance with AMCA Standard 204-05.
- D. Direct Drive EC Motor: Motor enclosures, Open type. Motor to be a DC electronic commutation type motor (EC) specifically designed for fan applications. AC induction type motors are not acceptable. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor or by an external 0-10 VDC signal. Speed control type shall be field convertible with both options available as a standard. Motor shall be a minimum of 85% efficient at all speeds.
- E. Vibration Isolation: Fan and drive frame shall be mounted rubber vibration isolators sized to match the weight of the fan.

- F. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection.
- G. Roof Curb: Provide 24" tall welded aluminum or galvanized roof curb with minimum 1.5" of internal rigid insulation.
 - 1. Provide with wind restraint clips and mounting hardware.
- H. Bird Screens: Provide removable bird screens, 1/2" mesh, 16- gauge aluminum or brass wire.
- I. A two-piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools.
- J. Dampers: Provide gravity-actuated dampers / motorized dampers with linkage / dampers in curb bases as scheduled on drawings.
- K. Acceptable Manufacturers:
 - 1. Greenheck.
 - 2. Loren Cook Co.
 - 3. Penn Ventilator Co., Inc.

2.12 CENTRIFUGAL IN-LINE FAN

- A. General: Provide AMCA certified inline centrifugal fan of type, size, and capacity as scheduled, and as specified herein
- B. Type: Centrifugal inline fan, direct driven as scheduled.
 - 1. Housing: Square design constructed of heavy gauge galvanized steel or aluminum with square duct mounting collars. Housing and bearing supports shall be constructed with bolted or welded steel fasteners. Construction shall include two removable access panels located perpendicular to the motor mounting panel. Panel shall be of sufficient size to permit access to all interior components.
 - 2. Wheel: Provide non-overloading backward inclined centrifugal wheel constructed of aluminum. Blades securely riveted or welded to heavy gauge back plate and wheel cone. Wheel shall be statically and dynamically balanced in accordance with AMCA Standard 204-05.
 - 3. Discharge Configuration: The fan discharge configuration shall be field convertible to accommodate a true inline discharge, right discharge or left discharge arrangement.
 - 4. Direct Drive EC Motor: Motor enclosures, Open type. Motor to be a DC electronic commutation type motor (EC) specifically designed for fan applications. AC induction type motors are not acceptable. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor or by an external 0-10 VDC signal. Speed control type shall be field convertible with both options available as a standard. Motor shall be a minimum of 85% efficient at all speeds.
- C. Electrical: Provide factory-wired NEMA 1 disconnect switch wired from fan motor to junction box for electrical connection.
- D. Vibration Isolation: Provide with hanging spring isolators specifically sized to accommodate the fan weight.
- E. Dampers: Provide gravity or motorized actuated damper as scheduled on drawings.
- F. Acceptable Manufacturers:

1. Greenheck.
2. Loren Cook Co.
3. Penn Barry

2.13 CEILING VENTILATORS

- A. Centrifugal Ceiling Exhausters: Provide AMCA certified centrifugal ceiling exhausters, designed for ceiling or wall mounting, of type, size and capacity as scheduled.
- B. Type: Provide galvanized steel housing lined with acoustical insulation, adaptable for ceiling or wall installation. Provide centrifugal fan wheels mounted on motor shaft with fan shrouds, all removable for service. Provide integral backdraft damper at fan discharge. Provide fan motor as scheduled and as specified herein.
- C. Grille: Provide integral grille with flange on intake with attachment to fan housing.
- D. Motor: Provide permanent split-capacitor motor, permanently lubricated, with grounded cord and plug. Furnish remote fan speed control, solid state, capable of controlling fan speed from full speed to approximately half speed.
- E. Electrical: Provide junction box for electrical connection on housing, and receptacle for motor plug-in.
- F. Accessories: Provide manufacturer's standard roof jack, brick vent, wall cap, and transition fittings as indicated on drawings or schedules.
- G. Acceptable Manufacturers:
 1. Greenheck.
 2. Loren Cook Co.
 3. Penn Ventilator Co., Inc.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which ductwork accessories and equipment are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF DUCTWORK

- A. General: Assemble and install ductwork in accordance with SMACNA standards and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.
- B. Inserts: Install concrete inserts for support of ductwork in coordination with framework, as required to avoid delays in work.
- C. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

- D. Field Modifications: Ductwork modified in the field shall maintain the same free area as shown on the Drawings. In no case shall the aspect ratio of modified ductwork exceed 4 to 1 without permission of the Engineer.
- E. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to ½" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- F. Electrical Equipment Spaces: Do not route ductwork through transformer vaults and their electrical equipment spaces and enclosures.
- G. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate.
 - 1. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate, in accordance with requirements of Division-07 Section "Firestopping".
- H. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards as follows:
 - 1. All supply, return and exhaust: Galvanized sheet metal.
 - 2. Ductwork to be painted: Galvanized, mill-phosphatized sheet metal ready for field painting.
- I. Sealant: Seal all supply, return and exhaust ductwork with duct sealant or duct cement in accordance with SMACNA HVAC Duct Construction Standards.
- J. Hangers, supports, strut, hardware and ductwork in Natatoriums, pool locker rooms, pool equipment rooms and chemical storage rooms, shall be field painted by the general contractor. Coordinate ductwork and hanger material with painting contractor prior to painting. The installing paint contractor shall provide preparation and painting suitable for the material used.

3.03 DUCT LEAKAGE TESTING

- A. Refer to Duct Fabrication in Part 2 above for duct construction schedule and allowable leakage rates and extent of leak testing.
- B. Installed ductwork shall be tested prior to installation of access doors, take-offs, etc.
- C. Contractor shall submit leak test reports to the engineer for review for each section of duct tested.
- D. The testing shall be performed as follows:
 - 1. Perform testing in accordance with HVAC Air Duct Leakage Test Manual.
 - 2. Use a certified orifice tube for measuring the leakage.
 - 3. Define section of system to be tested and blank off.
 - 4. Determine the percentage of the system being tested.
 - 5. Determine the allowable leakage (cfm) for that section being tested.
 - 6. Pressurize to operating pressure and repair any significant or audible leaks.

7. Repressurize and measure leakage.
8. Repeat steps 6 and 7 until the leakage measured is less than the allowable defined in step 5.

- E. NOTE: It is recommended that the first 100'-300' of ductwork installed be tested to ensure the quality of the workmanship at an early stage.

3.04 INSTALLATION OF DUCT LINER

- A. General: Install duct liner in accordance with SMACNA HVAC Duct Construction Standards. Duct sizes shown on plans are clear inside dimensions. Increase duct sizes accordingly.
- B. Extent of Duct Liner:
 1. Refer to specification section 23 0700, HVAC Insulation, for extent of duct liner and required thicknesses.

3.05 INSTALLATION OF FLEXIBLE DUCTS

- A. Maximum Length: For any duct run using flexible ductwork, do not exceed 8' - 0" extended length or as required by local authorities.
- B. Installation: Install in accordance with Section III of SMACNA's, "HVAC Duct Construction Standards, Metal and Flexible".

3.06 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90-degree elbows in supply, return and exhaust air systems, and elsewhere as indicated.
- C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- D. Install access doors for the following:
 1. Access to dampers.
 2. Access to fire dampers (one on each side of damper) in duct.
 3. Access to heating coils (one on each side of coil) in duct.
 4. Access to control devices.

3.07 INSTALLATION OF FIRE DAMPERS

- A. Install fire dampers per the manufacturer's installation instructions and in accordance with the current edition of UL-555 Standard for Fire Dampers.
- B. Fire Damper Identification: Access points, i.e. access doors, access panels, lay-in ceiling tile, etc., shall be permanently identified on the exterior of the access point by a label having letters not less than 0.5" in height reading "FIRE DAMPER".

3.08 INSTALLATION OF GRILLES, REGISTERS, AND DIFFUSERS

- A. General: Install grilles, registers and diffusers in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that products serve intended functions.
- B. Locate ceiling grilles, registers and diffusers, as indicated on general construction "Reflected Ceiling Plans".
- C. Provide code approved support for grilles, registers and diffusers in lay-in ceilings.

3.09 INSTALLATION OF FANS

- A. General: Install fans where indicated, in accordance with manufacturer's installation instructions, and with recognized industry practices, to ensure that fans comply with requirements and serve intended purposes.
- B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Ensure that rotation is in direction indicated and intended for proper performance. Do not proceed with fan start-up until wiring installation is acceptable to fan Installer.

3.10 EQUIPMENT CONNECTIONS

- A. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.11 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration. Clean existing ductwork to be reused.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- C. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

3.12 EXTRA STOCK

- A. Provide one complete extra set of filters for each air handling system. If system is designed to include pre-filters and after- filters, provide only pre-filters. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.

3.13 SPARE PARTS

- A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.
- B. Furnish to Owner, with receipt, one spare set of belts for each belt driven centrifugal fan.
- C. Furnish to Owner, with receipt, one set of filters for each unit requiring filters.

3.14 TRAINING OF OWNER'S PERSONNEL

- A. Provide services of manufacturer's technical representative for 1 day to instruct Owner's personnel in operation and maintenance of heating and cooling units.
 - 1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END SECTION

237302
PACKAGED ROOFTOP AIR HANDLING UNITS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Types of equipment specified in this section include the following:
 - 1. Rooftop Heating & Cooling Units.

1.02 SUBMITTALS

- A. Provide the following submittals:
 - 1. Rooftop Heating & Cooling Units.

1.03 SPECIAL PROJECT WARRANTY

- A. Warranty on Compressor and Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and/or heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.
 - 1. Warranty Period: 5 years from date of substantial completion.

1.04 TEST AND BALANCE COORDINATION

- A. Prior to starting work, the contract documents shall be given to the Test and Balance contractor for his review. If there are any areas of the air distribution system that cannot be balanced, due to the configuration of the system, a Request for Clarification shall be made in a timely manner to allow revisions to the documents before the systems are installed.

PART 2 PRODUCTS

2.01 PACKAGED ROOFTOP AIR CONDITIONING UNITS

- A. General Description
 - 1. Packaged rooftop unit shall include heat pump compressors, evaporator / condenser coils, hot gas re-heat coils, energy recovery wheel, bypass dampers, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, power exhaust fans, and factory provided and installed unit controls.
 - 2. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
 - 3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - 4. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
 - 5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
 - 6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
 - 7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
 - 8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

B. Construction

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
4. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 8 inches of positive or negative static pressure. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage. Cabinet leakage shall not exceed 1% of total airflow when tested at 6 inches of static pressure.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, heaters, return fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs on the top of the unit.
11. Unit base shall be fabricated of 3 inch thick double wall, impact resistant, rigid polyurethane foam panels.
12. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.

C. Electrical

1. Unit shall have a 30kAIC SCCR.
2. Unit shall be provided with factory installed and factory wired circuit breaker.
3. Air-source heat pump shall include a defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation. Defrost cycle shall begin when outdoor coil temperature is below a fixed setpoint and have a fixed 10 minute run time, or end when the outdoor coil temperature is above a fixed setpoint. Defrost timer, with 30/60/90 minute selectable defrost cycle interval time, shall be factory installed in the controls compartment. During defrost cycle all compressors shall energize, reversing valve shall de-energize, and auxiliary heat shall energize.
4. Unit shall be provided with a factory installed and factory wired 115V, 15 amp GFI outlet disconnect switch in the unit control panel.
5. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

D. Supply Fans

1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
3. Motor shall include shaft grounding

E. Exhaust Fans

1. Exhaust dampers shall be sized for 100% relief.
 2. Fans and motors shall be dynamically balanced.
 3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
 4. Access to fans shall be through double wall, hinged access doors with quarter turn lockable handles.
 5. Unit shall include direct drive, axial flow fans. Blades shall be adjustable pitch.
 6. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
 7. Motor shall include shaft grounding.
- F. Cooling Coils
1. Evaporator Coils
 - a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
 - b. Coils shall be 6 row high capacity.
 - c. Coils shall be hydrogen or helium leak tested.
 - d. Coils shall be furnished with factory installed expansion valves.
- G. Refrigeration System
1. Unit shall be factory charged with R-454B refrigerant.
 2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
 3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
 4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
 5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
 6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed liquid line filter driers.
 7. Unit shall include variable capacity scroll compressors on all refrigeration circuits which shall be capable of modulation from 10-100% of their capacity.
 8. Unit shall include factory provided and installed compressor sound jackets on all compressors.
 9. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.
 10. Each refrigeration circuit shall be equipped with a liquid line sight glass.
 11. Each additional capacity stage shall be equipped with an adjustable, 20 second delay timer to prevent multiple capacity stages from starting all at once.
 12. Unit shall be provided with an adjustable compressor lockout for each compressor.
 13. Each refrigeration circuit shall be provided with an adjustable temperature sensor freeze stat which shuts down the cooling circuits when the evaporator coil tubing falls below the setpoint
- H. Condensers
1. Air-Cooled Condenser
 - a. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.

- b. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
 - c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
 - d. Coils shall be hydrogen or helium leak tested.
 - e. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockout.
- I. Electric Heating
- 1. Unit shall include an electric heater consisting of electric heating coils, fuses and a high temperature limit switch, with capacities as shown on the plans.
 - 2. Electric heating coils shall be located in the reheat position downstream of the cooling coil.
 - 3. Electric heater shall have full modulation capacity controlled by an SCR (Silicon Controlled Rectifier). A 0-10 VDC heating control signal shall be field provided to control the amount of heating.
 - 4. RTU-# Auxiliary electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Auxiliary heating capacity shall be available for operation when heat pump heating is in operation. Unit shall include 1 stage of auxiliary electric heating capacity.
 - 5. Emergency electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is not in operation.
- J. Filters
- 1. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.
 - 2. Unit shall include a clogged filter switch.
 - 3. Unit shall include a Magnehelic gauge mounted in the controls compartment.
- K. Outside Air/Economizer
- 1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return DDC actuator. Unit shall include outside air opening bird screen, outside air hood, and relief dampers
- L. ERV-1: Energy Recovery
- 1. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.
 - 2. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
 - 3. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.

4. Unit shall include 2 inch thick, pleated panel outside air and exhaust air filters with an ASHRAE MERV rating of 13, upstream of the wheels.
 5. Hinged service access doors shall allow access to the wheel.
 - a. Polymer Energy Recovery Wheels
 - 1) Shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
 - 2) All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive.
 - 3) Polymer Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The 5-year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the Airxchange written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts.
 - 4) Sensible energy recovery wheels shall be constructed of lightweight polymer and shall be provided without desiccant coating and shall not degrade nor require additional coatings for application in marine or coastal environments. Segments shall be washable with detergent or alkaline coil cleaner and water.
 - 5) Energy recovery wheels shall be provided with modulating bypass dampers on the outside and exhaust air streams
 - 6) Energy recovery wheels shall be provided with VFD driven motor for frost prevention. The heat wheel must slow down when frosting conditions are present and run at full speed when there are no frosting conditions or economizer operation.
- M. Controls: Factory installed and factory provided control.
1. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested. Controller shall be capable of stand alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 2. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 3. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.
 4. Variable air Volume Controller.
 - a. Unit shall utilize a variable capacity compressor system, energy recovery wheel, bypass dampers, electric heating coils, heat pump modulating heating / cooling refrigeration system and variable speed supply and exhaust fans.
 - b. The factory controller shall control all unit components as required to maintain space temperature (SZVAV) or discharge air temperature (DOAS).
 - c. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible; to meet return air humidity loads and prevent supply air temperature swings and overcooling of the space.
 - d. With modulating heat option, a field installed supply air temperature sensor shall be furnished to control the amount of heating from the electric heating coils and heat pump refrigeration system as required. Supply air temperature setpoint shall be field adjustable.

5. Controller shall be provided with communications port and license to allow end user interfacing via the BACnet MSTP or IP protocol, coordinate interface type with successful TCC. Refer to temperature control drawings for intended sequence of operations. The DDC shall monitor and control the commercial rooftop unit in a stand-alone mode or as directed by the building automation system. Automation system to send control setpoints, zone CO2 signal, average or peak associated room temperature, occupancy mode and etc. to the factory controller via the interface card as required to meet the specified sequence of operations. Any discrepancies shall be identified by the manufacturer during the submittal process
 6. With the modulating hot gas reheat option a supply air temperature sensor shall be furnished with the unit for field installation. Suction pressure sensor shall be factory installed. Supply air temperature setpoints, for the dehumidification mode of operation, shall be adjustable.
- N. Outside Airflow Measuring Station.
1. The Air Flow Measurement Station (AFMS) shall consist of a microprocessor based transmitter and one or more sensor probes. The AFMS shall use the principle of thermal dispersion with one self heated and one zero power bead in glass thermistor at each sensing node. Only the thermistor shall be located within the sensing node, all other electronic components shall be outside the airstream. The transmitter (Gold Series Only) shall be provided with a Bluetooth low energy interface card capable of transmitting all transmitter setup parameters, diagnostics, average airflow and temperature of the device and the airflow and temperature of each sensor node. Software capable of capturing and displaying this transmission will be available via download to Android or iOS phone or tablet.
 2. The AFMS shall achieve an installed accuracy when installed in accordance with the manufactures recommended sensor density and placement guidelines as follows:
 - a. Ducted Applications: +/- 3% of Reading
 - b. Non Ducted Applications: +/- 3% to 5%
 3. Upon request the manufacture shall provide for approval and verification a written copy of the following:
 - a. 16 point NIST traceable report of calibration used for the reference standard.
 - b. UL/cUL 873 report listing the AFMS as a complete assembly.
 - c. Independent laboratory test report results of 100% survival rate in a 30 day saltwater and acid vapor test.
 4. Monitoring and configuration shall be performed through communication network to the BAS. Protocol to be coordinated with the temperature controls contractor.
 5. Acceptable manufacturers:
 - a. Ebtron GTL116-P+
 - b. Ruskin TDP05K
- O. Sensors: On single zone units provide the following factory zone sensors for field installation by the TCC.
1. Zone Temperature
 2. Zone Humidity
 3. Zone CO2
- P. Accessories
1. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.
 2. Curbs: Provide with custom sloped curb specifically designed to match roof slope. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished loose for field installation by the mechanical contractor.
 - a. Project requires seismic rated curbs, see 23 0548.
 - b. Refer to mechanical schedules for minimum curb heights. Height noted is minimum height from the base of the curb to the bottom edge or the roof flashing point.

- c. At contractors option flat roof curbs are acceptable where roof slopes are such that contractor can shim curb for a level rooftop unit mounting surface. Coordinate curb type with mechanical contractor prior to order.

Q. Acceptable manufacturers:

- a. Basis of Design:
 - 1) Aeon RN
- b. Prior Approved Equivalent
 - 1) All prior approvals shall require a pre-submittal to be reviewed and approved by the engineer and owner to be consider acceptable. Any product that has not been approved prior to bid day shall be rejected and the basis of design manufacturer shall be required to be provided.

PART 3 EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which ductwork accessories and equipment are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF ROOFTOP UNITS

- A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Install units on roof curb, in accordance with National Roofing Contractors Association (NRCA) installation recommendations.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- D. Start-up rooftop units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- E. Grounding:
 - 1. Provide positive equipment ground for rooftop unit components.

3.03 EXTRA STOCK

- A. Provide one complete extra set of filters for each air handling system. If system is designed to include pre-filters and after- filters, provide only pre-filters. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of installation of equipment and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible,

field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.05 EQUIPMENT CONNECTIONS

- A. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.06 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration. Clean existing ductwork to be reused.

3.07 SPARE PARTS

- A. Furnish to Owner, with receipt, one spare set of belts for each belt driven centrifugal fan.
- B. Furnish to Owner, with receipt, one set of filters for each unit requiring filters.

3.08 TRAINING OF OWNER'S PERSONNEL

- A. Provide services of manufacturer's technical representative for 1 day to instruct Owner's personnel in operation and maintenance of heating and cooling units.
 - 1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END SECTION

238100

ELECTRIC HEATING TERMINALS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Types of electrical heating terminals in this section include the following:
 - 1. Unit heaters.

1.02 SUBMITTALS

- A. See Section 01 3000 – Administrative Requirements, for submittal procedures.
- B. Provide the following submittals
 - 1. Propeller unit heaters.

PART 2 PRODUCTS

2.01 PROPELLER UNIT HEATERS

- A. Materials and Equipment: Except as otherwise indicated, provide manufacturer's standard electric propeller unit heater materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Heating Elements:
 - 1. General: Except as otherwise indicated, provide manufacturer's standard elements of indicated duty and rated for indicated capacity, consisting of resistance elements in steel sheath with extended fins, or in spiral sheath.
 - 2. Casings: Provide casings braced and reinforced to provide required stiffness, and containing heating element supports. Provide rounded corners. Phosphatize and paint casings inside and out with single coat of baked-on enamel; zinc plate hardware. Include fan orifice (venturi) in casing, as well as threaded hanger connections (weld nuts). Fabricate from 18-gauge steel.
- C. Air Deflectors: Provide manufacturer's standard air deflectors.
- D. Motors:
 - 1. Motors: Provide totally enclosed shaded-pole, or permanent-split capacitor motors, class "B" insulation, resiliently mounted, tap wound with built-in thermal overload protection, sleeve bearings, or permanently lubricated ball bearings. Electrical characteristics: as scheduled.
 - 2. Motor Controls: Provide remote, wall mounted, multi-speed motor control switch with "OFF" position.
 - 3. Internal Wiring: Provide high temperature, heat-resistant wiring enclosed in flexible metal conduit extending from terminal junction box to electrical devices. Provide fuses in motor and control circuit wiring.
- E. Fans:
 - 1. General: Provide aluminum propeller fans, balanced statically and dynamically of indicated capacity. Provide fans suitable for standard or spark-proof application.
 - 2. Vibration Isolation: Refer to Division-23 sections.
- F. Acceptable Manufacturers:
 - 1. Berko Electric.
 - 2. Erincraft Mfg Co, Inc.
 - 3. Markel Electric Heating.
 - 4. Q'Mark.
 - 5. Trane Co.

PART 3 EXECUTION

3.01 INSTALLATION OF HEATING TERMINALS

- A. Install heating terminal units as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices; complying with applicable installation requirements of NEC and NECA's "Standard of Installation".
- B. Coordinate with other electrical work, including wiring/cabling work, as necessary to properly interface installation of heating terminal units with other work.
- C. Clean dust and debris from each heating terminal as it is installed to ensure cleanliness.
- D. Comb out damaged fins where bent or crushed before covering elements with enclosures.
- E. Touch-up scratched or marred heating terminal enclosure surfaces to match original finishes.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.

3.02 GROUNDING

- A. Provide equipment grounding connections as indicated. Tighten connections to comply with tightening torque values specified in UL Std 486A to assure permanent and effective grounds.

3.03 TESTING

- A. Upon completion of installation of heating terminals and after building circuitry has been energized, test heating terminals to demonstrate capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance.

END SECTION

260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Common electrical installation requirements.

1.03 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

1.04 ELECTRICAL WIRING AND SAFETY DEVICE DELINEATION OF RESPONSIBILITIES

- A. Unless otherwise indicated, all HVAC equipment motors and controls shall be furnished, set in place, and wired in accordance with the following schedule: MD = HVAC Division, ED = Electrical Division, TD = Temperature Control Division, I = Installer of equipment requiring electrical service.
- B. Note: If Temperature Control Division is a subcontract to the HVAC Contractor, both MD and TD shall fall under the responsibility of MD. If no Temperature Control Contractor is under contract, MD shall assume all Temperature Control responsibilities.
- C. Coordinate with Division 22 and Division 23 contractor within 30 days after award of contract to obtain complete summary list of all HVAC and Plumbing equipment requiring electric power. This list shall summarize equipment power loads/ line voltage control requirements, quantities, and location of equipment and connection points. The list shall clearly identify specific HVAC, Plumbing, and controls equipment that shall operate on emergency or standby power.

	Furnished Under	Set In Place or Mounted Under	Power Wired & Connected Under	Control Wired & Connected Under
1. Other Equipment Motors/Starters	I	I	ED	I
2. Plumbing Equipment Motors	PD	PD	ED	TD
3. HVAC Equipment Motors	MD	MD	ED	TD
4. HVAC Magnetic Motor Starters, VFD's	MD	MD	ED	TD
5. Control Wiring Regardless of Voltage	TD	TD	TD See footnote 1	TD
6. Control Components: Control Relays, Thermostats, Control Transformers, EP, PE Switches	TD	TD	TD See footnote 1	TD
7. Temperature Control Panels, Time Clocks, Controllers	TD	TD	TD See footnote 1	TD

	Furnished Under	Set In Place or Mounted Under	Power Wired & Connected Under	Control Wired & Connected Under
8. Valve and Damper Motors and Actuators	TD	TD	TD See footnote 1	TD
9. Control Valves, Solenoid Valves	TD	MD	--	TD
10. Control Dampers Integral with a Fan Unit	MD	MD	--	--
11. Control Dampers (duct mounted)	TD	MD	--	TD
12. Thermowells in Piping	TD	MD	--	--
13. Fire Protection (Exterior Horn & Light)	FD	ED	ED	ED
14. Fire Protection (Tamper & Flow Switch)	FD	FD	ED	ED See footnote 3
15. Smoke Duct Detectors (including relays)	ED See footnote 3	MD See footnote 3	ED See footnote 4	ED See footnote 3
16. Fire and Smoke Dampers	MD	MD	ED	ED See footnote 2
17. Pushbutton Stations and Pilot Lights	MD	MD	ED	TD See footnote 4
18. Manual Operating Switches	MD	MD	ED	-- See footnote 5
19. Multi-speed Switches (not integral with Equipment served)	MD	MD	ED	-- See footnote 5
20. Fused and Unfused Disconnect Switches & Thermal Overload Switches	ED See footnote 6	ED See footnote 6	ED	--
21. Contactors	ED	ED	ED	ED
22. Temporary Heating Connection	MD	MD	ED	TD
23. Water Heater Controls	PD	PD	TD See footnote 1	TD
24. Boiler Controls, Boiler Burner Control Panels Internally Wired	MD	MD	TD See footnote 1	TD
25. Remote Disconnect Switches for Boiler (Heating, Domestic HW & Pool Heat) Controls per ASME-CSD-1.	TD	TD See footnote 7	TD See footnote 8	TD

- Footnote 1: It is the intention of this specification for all conduit and wiring which connects to control equipment or provides controls to HVAC equipment to be provided by the Temperature Control Contractor. Other portions of the specification which may conflict with this concept shall be brought to the attention of the engineer for clarification prior to bidding the project. The ED shall provide line voltage wiring conduit and junction boxes for the express purpose of temperature controls. It shall be the responsibility of the Temperature Control Contractor to coordinate the location of the junction boxes (if not otherwise shown on the Electrical Drawings) and to utilize these junction boxes for temperature control wiring. The Temperature Control Contractor shall extend line and/or low voltage wiring from junction boxes to all HVAC and control components which require control wiring.

2. Footnote 2: Wiring from the fire alarm electrical contacts to fire alarm system control panel by ED; all HVAC/Plumbing equipment control function wiring by TD. ED to coordinate locations of electrical contact with MD. MD to coordinate locations of duct smoke detectors with ED.
3. Footnote 3: MD shall assist in locating the detectors, but ED shall verify that the installation meets the manufacturer's installation guidelines, and ED is responsible for correctly ordering the smoke detectors. MD shall mount the detectors in a manner directed by ED according to manufacturer's recommendation. If the detector is used for operation of a smoke/fire damper, the control wiring will be by ED. If the unit is used for fan shutdown, the fire alarm functions will be by ED and the wiring to the starter or VFD for a direct shutdown will be by MD, typically by the TD. Any signal required for the sequence of operation shall be coordinated between MD and ED, with ED providing a point of connection and MD responsible for the remainder of the installation.
4. Footnote 4: For connection to auxiliary contacts if required.
5. Footnote 5: Device is used in the power wiring circuit to the equipment. Control functions do not exist.
6. Footnote 6: Unless furnished with equipment.
7. Footnote 7: A manually operated remote shutdown switch(es) shall be located just outside the boiler room door and marked for easy identification. Consideration should be given to the type and location of the switch to safeguard against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door. The emergency shutdown switch shall be wired to the boiler safety circuit relay and shall disconnect all power to the boiler safety circuit.
8. Footnote 8: TD shall provide 24V to emergency power off switches.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, coordinate the installation of components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

END OF SECTION

260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Copper building wire rated 600 V or less.
 - 2. Metal-clad cable, Type MC, rated 600 V or less.
 - 3. Connectors, splices, and terminations rated 600 V and less.

1.02 ACTION SUBMITTALS

- B. See Section 01 3000 - Administrative Requirements for submittal procedures.
- C. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.01 BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.

2.02 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Alcan Products Corporation; Alcan Cable Division.
 2. American Insulated Wire Corp.; a Leviton Company.
 3. General Cable Corporation.
 4. Senator Wire & Cable Company.
 5. Southwire Company.
- C. Standards:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. Comply with UL 1569.
 3. RoHS compliant.
 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Circuits:
 1. Single circuit.
 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- F. Ground Conductor: Insulated.
- G. Conductor Insulation:
 1. Type TFN/THHN/THWN-2: Comply with UL 83.
- H. Armor: Steel, interlocked.
- I. Jacket: PVC applied over armor.

2.03 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 1. Material: Copper.
 2. Type: One hole with standard barrels.
 3. Termination: Compression.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

- B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- E. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- F. Minimum wire size shall be #12AWG.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Type MC.
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- H. Feeders have been sized to limit voltage drop to 2%. The contractor shall increase branch circuit conductors, as required, to limit voltage drop in each branch circuit to 3%.

3.04 CONNECTIONS

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

- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. All wiring connections made at or below grade shall be waterproof with UL listed waterproof connectors.

3.05 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.07 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.

3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

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260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.02 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For each type of product indicated.
- C. Sustainable Design Submittals:

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1) Ground rods.
 - 2) Ground rings.
 - 3) Grounding arrangements and connections for separately derived systems.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.02 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.03 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- J. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- K. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- L. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- M. Water Pipe Clamps:
 - 1. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.04 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard

grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

- F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- G. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare, copper, not less than No. 8 AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.05 FENCE GROUNDING

- 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 at 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 grounding location.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- F. 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.

3.06 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. Use exothermic welds for all below-grade connections.
 - 3. For grounding electrode system, 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, and connect to the service grounding electrode conductor.

- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
 - 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 - 2. Bond grounding conductor to re-inforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- I. 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 are 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.

3.07 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 2. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems.
 - 2. Aluminum slotted support systems.
 - 3. Conduit and cable support devices.
 - 4. Structural steel for fabricated supports and restraints.
 - 5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

1.02 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Unistrut; Tyco International, Ltd.
 - b. Allied Tube & Conduit.
 - c. Cooper B-Line, Inc.; a division of Cooper Industries.
 - d. ERICO International Corporation.
 - e. GS Metals Corp.
 - f. Thomas & Betts Corporation.
 - g. Wesanco, Inc
 - 2. See Section 05 4300 for other Slotted Channel specifications.
 - 3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 4. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Width: Selected for applicable load criteria.
 4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
 6. Rated Strength: Selected to suit applicable load criteria.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA 101
 3. NECA 102.
Metal cable tray systems.
 4. NECA 105.
 5. NECA 111.
- B. Natatorium Environments:
1. Exposed: Galvanized Rigid Steel with HPC System.
 2. Above Ceiling: Galvanized Rigid Steel.

3. Suspended, Exposed, Lighting: Multi-Point Rigid Suspension. Aircraft Cable is Not Acceptable.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, GRC, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Surface raceways.
 - 5. Boxes, enclosures, and cabinets.
 - 6. Handholes and boxes for exterior underground cabling.

1.02 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.

1.03 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- C. Sustainable Design Submittals:
- D. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems, Inc.
 - b. Alflex Inc.
 - c. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - d. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - e. Electri-Flex Co.
 - f. Manhattan/CDT/Cole-Flex.
 - g. Maverick Tube Corporation.
 - h. O-Z Gedney; a unit of General Signal.
 - i. Wheatland Tube Company.
 - 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. GRC: Comply with ANSI C80.1 and UL 6.
 - 4. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.
 - 5. EMT: Comply with ANSI C80.3 and UL 797.

6. FMC: Comply with UL 1; zinc-coated steel or aluminum.
 7. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- B. Metal Fittings:
1. Comply with NEMA FB 1 and UL 514B.
 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. Fittings, General: Listed and labeled for type of conduit, location, and use.
 4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 5. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Set-screw for conduits less than 2" and compression type for conduits 2" or larger.
 6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- C. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

- A. Nonmetallic Conduit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems, Inc.
 - b. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - c. Arnco Corporation.
 - d. CANTEX Inc.
 - e. CertainTeed Corp.; Pipe & Plastics Group.
 - f. Condux International, Inc.
 - g. ElecSYS, Inc.
 - h. Electri-Flex Co.
 - i. Lamson & Sessions; Carlon Electrical Products.
 - j. Manhattan/CDT/Cole-Flex.
 - k. RACO; a Hubbell Company.
 - l. Thomas & Betts Corporation.
 - m. <Insert manufacturer's name
 2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
 4. LFNC: Comply with UL 1660.
- B. Nonmetallic Fittings:
1. Fittings, General: Listed and labeled for type of conduit, location, and use.
 2. Fittings for RNC: Comply with NEMA TC 3; match to conduit and material.
 - a. Fittings for LFNC: Comply with UL 514B.
 3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Cooper B-Line, Inc.
 - b. Hoffman.
 - c. Square D; Schneider Electric.

- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R as indicated on plans unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. 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.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.04 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell Company.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet Division.
 - 10. Spring City Electrical Manufacturing Company.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 5. Slab on Grade: Hubbell #4X33(box) with X #S3825(decora-flap brass covers) and #SB308X (carpet flange). Or Wiremold (Walker) #880CSX (box), with #8X7B (flange) and X #828GFI (decora-flap brass covers). X = size of box, per drawings. Provide matching number of covers.
 - 6. Over Concrete Plank (Shallow): Hubbell #B4X14(box) with X #S3825(decora-flap brass covers) and #SB308X (carpet flange). Or Wiremold (Walker) #880CMX (box), with #8X7B (flange) and X #828GFI (decora-flap covers). X = size of box, per drawings. Provide matching number of covers.
 - 7. Wood Floor: Wiremold (Walker) #880WX (box), with #8X7B (flange) and X #828GFI (decora-flap brass covers). X = size of box, per drawings. Provide matching number of covers.
- G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- N. Gangable boxes are allowed.
- O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, or Type 4, as indicated on the plans, with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- P. Cabinets:
 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.05 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Quazite by Hubbell Power Systems.
 - b. Armorcast Products Company.
 - c. Carson Industries LLC.
 - d. CDR Systems Corporation.
 - e. NewBasis
 2. Standard: Comply with SCTE 77.
 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 6. Cover Legend: Molded lettering, identifying system serviced.
 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Quazite by Hubbell Power Systems.
 - b. Armorcast Products Company.
 - c. Carson Industries LLC.
 - d. Christy Concrete Products.
 - e. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
 2. Standard: Comply with SCTE 77.
 3. Color of Frame and Cover: Gray.
 4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 7. Cover Legend: Molded lettering, identifying system serviced.
 8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 9. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Underground Conduit subject to vehicular travel: RNC, Type EPC-80-PVC.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
 7. Natatorium, Exposed: GRC.
 8. Natatorium, In-Wall: GRC.
 9. Natatorium, Above Ceiling: GRC.

10. Natatorium-Adjacent Locker Rooms, Exposed: GRC.
 11. Natatorium-Adjacent Locker Rooms, In-Wall: GRC.
 12. Natatorium-Adjacent Locker Rooms, Above Ceiling: GRC.
 13. Chemical Rooms, Exposed: PVC.
 14. Chemical Rooms, In-Wall: PVC.
 15. Pool Mechanical Rooms, Exposed: GRC or PVC.
 16. Pool Mechanical Rooms, In-Wall: GRC.
 17. Pool Storage Rooms, Exposed: GRC.
 18. Pool Storage Rooms, In-Wall: GRC.
 19. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens, damp or wet locations, and natatorium environments.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.
- H. Conduits in a crawl space, if not supported from structure, shall be buried in at least 6" of soil.

3.02 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 5. Change from ENT to GRC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
1. Use EMT for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with 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 according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.

3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- W. Expansion-Joint Fittings:
 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

- GG. Where installed in fire-rated partitions, apply firestop putty pads or similar fire rated products on or around outlet boxes as required to maintain the fire rating of the partition.
- HH. Support outlet boxes and switch boxes from two (2) adjacent studs. Outlet boxes designed to attach to one metal stud and be "sandwiched" between the front and back layers of Gypsum Wallboard are not allowed.
- II. Back-to-back outlets in commons walls are not permitted. Outlet boxes shall be separated by at least one stud wherever possible. In cases of outlet boxes of adjacent rooms in the same stud cavity at the same height, provide a layer of expandable spray foam insulation around each box in that cavity. There must be a minimum of a 1" horizontal separation space between boxes of adjacent rooms. If this condition occurs in a fire rated wall, provide a 1-hour fire rated putty pad to cover the back of outlets of one side of the partition. Other junction box installations on fire rated walls shall comply with UL requirements.
- JJ. Where shown adjacent to receptacles, telephone, data and cable TV outlets shall be located no further than 6" on center from the center of the receptacle. Cable television outlets and telephone outlets shall be combined in a single faceplate in resident units.
- KK. Contractor shall not install conductors or cables in a building that is not completely waterproofed, unless the conductors or cable is rated for wet location installations.
- LL. Route circuit homeruns down corridors, above accessible ceilings.
- MM. Minimum burial depth for underground conduit shall be 24".

3.03 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Section 312000 "Earth Moving."
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
 - 6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
 - 7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.06 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.07 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

260544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

1.02 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For each type of product.
- C. Sustainable Design Submittals:

PART 2 - PRODUCTS

2.01 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

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260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Labels.
 - 3. Bands and tubes.
 - 4. Tapes and stencils.
 - 5. Tags.
 - 6. Signs.
 - 7. Cable ties.
 - 8. Paint for identification.
 - 9. Fasteners for labels and signs.

1.02 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For each type of product.
- C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage.
- B. Color-Coding for Phase-and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.

- b. Phase B: Red.
- c. Phase C: Blue.
- 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
- 4. Color for Neutral: White.
- 5. Color for Equipment Grounds: Green.
- 6. Colors for Isolated Grounds: Green with white stripe.
- C. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- D. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
- E. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.03 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester flexible label with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.04 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.05 TAPES AND STENCILS

- A. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
- B. Underground-Line Warning Tape:
 - 1. Tape:

- a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
2. Color and Printing:
- a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.06 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
- C. Write-on Tags:
1. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
 2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.07 SIGNS

- A. Baked-Enamel Signs:
1. Preprinted aluminum signs punched or drilled for fasteners, with colors, legend, and size required for application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal Size: 7 by 10 inches.
- B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal Size: 10 by 14 inches.
- C. Laminated Acrylic or Melamine Plastic Signs:
1. Engraved legend.
 2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.08 CABLE TIES

- A. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- K. Vinyl Wraparound Labels:
 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

- L. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- M. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- N. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- O. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- Q. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- R. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- U. Underground Line Warning Tape:
- V. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 12 to 14 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
 - 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- W. Metal Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using plenum-rated cable ties.
- X. Nonmetallic Preprinted Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using plenum-rated cable ties.
- Y. Write-on Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using plenum-rated cable ties.
- Z. Baked-Enamel Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.
- AA. Metal-Backed Butyrate Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

BB. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

CC. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.03 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30A and 120V to Ground: Identify with self-adhesive raceway labels.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 1. "POWER."
 2. "FIRE ALARM"
 3. "TELECOM"
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

- L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
 - 1. Apply to exterior of door, cover, or other access.
- N. Arc Flash Warning Labeling: Self-adhesive labels.
- O. Operating Instruction Signs: Baked-enamel warning signs.
- P. Disconnect Means for Equipment: Indicate the equipment being served and the panelboard circuit numbers that are being utilized.
- Q. Equipment Identification Labels:
 - 1. Indoor Equipment: Baked-enamel signs.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 - 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations.
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers.
 - j. Enclosed switches.
 - k. Enclosed circuit breakers.
 - l. Enclosed controllers.
 - m. Variable-speed controllers.
 - n. Push-button stations.
 - o. Power-transfer equipment.
 - p. Contactors.
 - q. Remote-controlled switches, dimmer modules, and control devices.
 - r. Battery-inverter units.
 - s. Battery racks.
 - t. Power-generating units.
 - u. Monitoring and control equipment.
 - v. UPS equipment.

END OF SECTION

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260800

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes commissioning process requirements for electrical systems, and equipment.
- B. The purpose of this Section is to define Contractor responsibilities in the commissioning process. Electrical equipment, component, and system testing may be required under other Division 26 Specification Sections.
- C. Commissioning requires the participation of the Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. General Commissioning requirements and coordination are detailed in Division 01. Division 26 Contractors shall be familiar with all parts of Division 01 and shall execute all Commissioning responsibilities assigned to them in the Contract Documents and include the cost of Commissioning in the Contract price.

1.2 DEFINITIONS

- A. Automated Lighting Controls: Equipment, devices and programming associated with occupancy, scheduling and daylighting control.
- B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. The Commissioning Plan is not a contractual document and summarizes the contractual and process requirements included in the contract documents.
- C. CxP: Commissioning Provider.
- D. Deferred Tests: Functional Performance or Integrated System Tests performed after Substantial Completion due to partial occupancy, partial equipment acceptance, seasonal requirements, design, or other site conditions that prohibit the test from being performed prior to Substantial Completion.
- E. Pre-Testing: Functional Performance Testing occurring prior to system installations being substantially complete and the CxP receiving the Testing Prerequisite documentation. Typically, Pre-Testing efforts occur when Building Code or Authorities Having Jurisdiction require testing for the final electrical inspections or Certificate of Occupancy.
- F. Start-up: The activities where equipment is initially energized, tested and operated. Start-up is completed prior to Functional Performance Tests.
- G. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- H. Test Requirements: Requirements specifying what systems, modes and functions, etc. must be tested. Test requirements are not detailed test procedures. Test requirements and acceptance criteria specified in the Contract Documents.

- I. Test Prerequisites: Documentation and activities required to be completed by the Contractor(s) in advance of testing activities. Prerequisites include start-up, product data cut-sheets and shop drawing submittals.

1.3 ELECTRICAL EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

- A. Automated Lighting Controls

1.4 DOCUMENT SUBMISSION REQUIREMENTS

- A. Start-up Plan: The CxP shall witness start-up Contractor and Manufacturer activities. The Division 26 Contractor(s) responsible for start-up of any equipment shall develop a Start-Up Plan for equipment being commissioned. The primary role of the CxP in this process is to review the Start-up Plan(s) created by the Contractors, witness start-up of equipment and review the completed Start-up Plan(s) prior to Contractor, Manufacturer and functional performance testing associated with the Commissioning Process.
 - a. Organize and submit for review a binder of blank documents with sufficient detail, which upon project completion, will demonstrate the commissioned systems and equipment have been fully inspected and started in accordance with manufacturer's recommendations and standard industry procedures. At minimum this Plan must include:
 - 1) Automated Lighting Controls
 - 2) Manufacturer's installation procedures.
 - 3) Room by room (circuit by circuit) checkout sheet for each device, scene and relay.
 2. Submit the Start-up Plan to the CxP for review and comment prior to any Start-up activities commencing.
- B. Lighting and Automated Lighting Control System: As part of the Shop Drawing Submittal process, lighting control system equipment and device floorplan layouts, created by the equipment manufacturer or sales representative for the project, shall be submitted and approved by the Design Team prior to commencing the lighting control system programming. This submittal shall include, at a minimum, information describing the following system functionality:
 1. Lighting Control System and Device General Requirements:
 - a. Indicate how all interior lighting shall be controlled
 - b. Indicate how all exterior lighting shall be controlled
 - c. Indicate night lighting control requirements and schedule
 - d. Indicate egress lighting source and control requirements
 2. Lighting Control System Device Requirements:
 - a. Wall Switching Requirements:
 - 1) Indicate if the switch is ON/OFF or a dimmer
 - 2) Indicate switching voltage requirements, including line-voltage or low-voltage
 - 3) Include switch functionality modes such as: occupancy, vacancy, timer, or dimmer, as required
 - 4) Indicate switch functionality limits, as required
 3. (ceiling mounted) Occupancy Sensor Requirements:
 - a. Indicate which sensors shall function in occupancy mode
 - b. Include sensor timeout
 4. (ceiling mounted) Vacancy Sensor Requirements:
 - a. Indicate which sensors shall function in vacancy mode
 - b. Include sensor timeout

5. Daylight Sensor Requirements:
 - a. Indicate the footcandle setpoint for each space that has a daylight sensor
 - b. Indicate the daylight sensor control type (dimming, stepped, on/off, etc.)
 6. Lighting Control System Relay Panel and Controller Requirements:
 - a. Include lighting zone control requirements
 - b. Include software programming requirements
 - 1) Scheduled event control
 - c. Include wiring requirements
 7. Lighting Control System and Device General Requirements:
 - a. Indicate how all interior
 8. Description of any interface intent with the Building Automation System, or similar systems, including, but not limited to the following:
 - a. Product Data submittal and description of the interface equipment and components required to communicate with the Building Automation System.
 - b. Project specific description and list of all readable and writable Lighting Control System points available to the Building Automation System.
- C. Lighting Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at a minimum the following data on the control system and submit the Design Team for review and approval:
1. Complete installed luminaire schedule;
 2. Lamp and ballast (or LED device) details;
 3. Final aiming settings for adjustable angle luminaires;
 4. Final programming, schedules and calibration settings for the lighting controls;
 5. Warranties, manufacturers and distributors for each component used in the system; and
 6. A recommended schedule for inspection and recalibration for lighting control systems, subsystems, equipment and components.

1.5 PROBLEM SOLVING

- A. The CxP may recommend solutions to deficiencies identified during functional testing, startup and other commissioning activities.
- B. The burden of responsibility to solve, correct and retest deficiencies is with the Contractors and the Design Team.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxP.
- B. Attend commissioning meetings.
- C. Provide information requested by the CxP for final commissioning documentation.
- D. Notify the CxP in writing a minimum of (10) ten business days prior to lighting control system programming.
- E. Provide CxP with lighting control system setpoints and schedule inputs as defined in above and/or in the Lighting Control System specification section.
- F. If the Contractor requires testing commence to facilitate code or contractual requirements and the CxP has not received the Testing Prerequisites and the system installations are not

Substantially Complete, then time and expenses incurred by the CxP to complete any Pre-Testing shall be the responsibility of the Contractor.

1.7 CXP'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Electrical systems, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Provide current transformer devices to the Contractor for placement and direct which equipment and components require temporary monitoring.

1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxP for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Process for completing construction checklists and manufacturer's prestart and startup checklists for Electrical systems, equipment, and components to be verified and tested.
 - 3. Certificate of readiness, signed by the Contractor, certifying that Electrical systems, equipment, components, and associated controls are ready for testing.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that Electrical systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Construction Phase
 - 1. In each purchase order or subcontract that is written for changes in scope, include the following requirements for submittal data, Commissioning documentation, testing assistance, Operating and Maintenance (O&M) data, and training, as a minimum.
 - 2. Provide manufacturer's data sheets and shop drawing submittals of equipment.
 - 3. Provide additional requested documentation to the Contractor, prior to O&M manual submittals, for development of Functional Performance Tests procedures.
 - a. Typically, this will include detailed manufacturer's installation and Start-up, operating, troubleshooting and maintenance procedures, full details of any Owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.
 - b. This information and data request may be made prior to normal submittals.
 - 4. Submit manufacturer's detailed Start-up procedures and other requested equipment documentation to CxP for review.
 - 5. Address current A/E and Owner punch list items before Functional Performance Tests.
 - 6. Provide skilled technicians, familiar with the project and equipment, to execute start-up of equipment and to assist in execution of Functional Performance Tests. Ensure that they are available and present during the agreed-upon schedules and for a sufficient duration to complete the necessary tests, adjustments, and problem solving.

7. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxP, Owner and A/E and retest the system and equipment.
 8. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
 9. Certify that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
 10. Execute Start-Up Plan
 - a. Two weeks prior to each startup, the Division 26 Contractors shall confirm the scheduled start-up with the Owner, A/E and CxP.
 11. The CxP and possibly the A/E will observe the procedures and tests for selected pieces of primary equipment. It is the intent the CxP will observe the tests during contractor testing. If the contractor does not inform the CxP of testing, the CxP may request the contractor to repeat the test.
 12. The CxP will observe the physical start-up of select major systems.
 13. The Subs and vendors shall execute startup and update the Start-Up Plan with a signed and dated copy of the completed start-up checklists. The Construction Manager reviews for completion and accuracy, then submits to the CxP.
 14. Only individuals that have direct knowledge and witnessed that a line item task on the checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.
 15. Completed startup test reports must be provided to CxP prior to functional testing.
- B. Warranty Phase
1. If any check or test cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, execution of such test may be delayed to later in the Warranty Period, upon approval of the Owner. Contractor shall reschedule and conduct these unforeseen deferred tests in the same manner as deferred tests.
 2. Contractor shall correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

3.2 GENERAL TESTING REQUIREMENTS

- A. Testing will not be initiated until the testing prerequisites have been completed. For Electrical Systems being commissioned, the testing prerequisites are: execution of the Electrical Startup Plan and Electrical Shop Drawings meeting the requirements of section 1.4 of this specification section. The CxP must receive documentation indicating the testing prerequisites are fully complete 5 business days prior to commencement of the functional performance testing. Any testing executed prior to the receipt of the testing prerequisites may be determined by the CxP as Pre-Testing.
- B. Tests will be performed using design conditions whenever possible.
- C. Simulated conditions may need to be imposed when it is not practical to test under design conditions. Set simulated conditions as directed by the CxP and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- D. The CxP may direct that set points be altered when simulating conditions is not practical.
- E. The CxP may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

- F. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.3 DEMONSTRATION, VERIFICATION AND VALIDATION

- A. The electrical systems demonstration shall include, at minimum, the following:
 - 1. Lighting Control Systems: Contractor to self-perform 100% testing of lighting control equipment prior to scheduling demonstration with CxP. Demonstrate that all functions of the lighting control systems meet the specified requirements.
 - a. Check all occupancy sensor placement and test reliability of activation/deactivation.
 - b. Test photocells for functionality and accuracy.
 - c. Check all switches to ensure proper operation and circuiting.
 - d. Individually check all lighting panel schedules to ensure that room numbers and areas are correctly listed and they are programmed per the Owner's direction.
 - e. Test operation of circuits by changing system Date and Time to cause various circuits to switch modes. For rooms with occupancy sensors, validate the circuit energizes with occupancy in the space after the lights have been swept off. Test warning flicker prior to off sweep. Test cleaning and shed features.
 - f. For exterior fixtures, simulate night mode to validate function. Measure and record light level to ensure they meet the requirements and are generally provide adequate security. Check for excessive light level fluctuations or dark spots.

3.4 PARTICIPATION

- A. Required participating parties are indicated with the individual tests. Typically, multiple parties are required for any given test, yet participation for any given party is only required for the respective portion of the test for which the party is responsible.
- B. No party involved with the Project is prohibited from participation in or witnessing of any tests. Any Subcontractor may elect to witness all tests on their systems even if their involvement is not directly required

END OF SECTION

260923

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Outdoor and indoor photoelectric switches.
 - 3. Indoor occupancy sensors.
 - 4. Outdoor motion sensors.

1.02 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

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

1.05 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.01 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers listed in the Lighting Controls Notes in the drawings.
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
 - 1. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
 - 2. Astronomic Time: All channels.
 - 3. Battery Backup: For schedules and time clock.

2.02 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers listed in the Lighting Controls Notes in the drawings.

- B. Description: Solid state, with dry contacts, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
 - 2. Time Delay: 15-second minimum, to prevent false operation.
 - 3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 - 4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.03 INDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers listed in the Lighting Controls Notes in the drawings.

- B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
 - 1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 2. Relay Unit: Dry contacts rated for 20A load at 120- and 277-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - 3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
 - 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 - 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.04 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers listed in the Lighting Controls Notes in the drawings.

- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 3. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 4. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 - 5. Bypass Switch: Override the on function in case of sensor failure.
 - 6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
 - 1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.
- D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.05 OUTDOOR MOTION SENSORS (PIR)

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers listed in the Lighting Controls Notes in the drawings.
- B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.
1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 3. Bypass Switch: Override the on function in case of sensor failure.
 4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.
- C. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
- D. Detection Coverage: Up to 100 feet, with a field of view of 60 degrees.
- E. Lighting Fixture Mounted Sensor
- F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
1. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

PART 3 EXECUTION

3.01 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.02 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.03 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.04 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

3.05 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to 2 visits to Project during other-than-normal occupancy hours for this purpose.

3.06 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

260943

NETWORK LIGHTING CONTROLS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes manually operated, PC-based, digital lighting controls with external signal source and control module.
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multipole contactors.

1.02 DEFINITIONS

- A. BACnet: A networking communication protocol that complies with ASHRAE 135.
- B. BAS: Building automation system.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- E. PC: Personal computer; sometimes plural as "PCs."
- F. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.
- C. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
 - 1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
- D. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
- E. Field quality-control test reports.
- F. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

- G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with NFPA 70.

1.05 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of lighting control functions.
 - 2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
 - 3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.
- B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of software input/output to execute switching or dimming commands.
 - b. Failure of modular relays to operate under manual or software commands.
 - c. Damage of electronic components due to transient voltage surges.
 - 2. Warranty Period: 5 years from date of Substantial Completion.
 - 3. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

1.07 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. Electrically Held Relays: Equal to 10 percent of amount installed, but no fewer than 15 relays.

1.08 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for 2 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within 2 years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.
 - 1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers listed in the Lighting Controls Notes shown on the drawings.

2.02 SYSTEM REQUIREMENTS

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
- B. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

2.03 CONTROL MODULE

- A. Control Module Description: Programmable, PC-based unit with 17-inch color video monitor and keyboard for graphic display and programming of system status and to override breaker status; and to display status of local override controls and diagnostic information. If the control module is applied to emergency lighting units, control unit shall indicate failure of normal power and that the lighting units are, or are not, powered by the alternate power source.
 1. Display: Single graphic display for programming lighting control panelboards.
 2. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.
 3. Interoperability: Control module shall be configured to connect to BACnet-compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.
 4. Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with their PCs. Software shall be written for Windows operating system, with Web page as the display and ActiveX controls that can be accessed through an Internet browser. Include at least three levels of password protection. Include an egress lighting option that will provide each user with a lighted path for exiting the building after normal working hours.
 5. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
 6. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
 7. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
 8. Astronomic Control: Automatic adjustment of dawn and dusk switching.
 9. Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.
 10. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.
 - a. Software shall interpret status signals, provide for their display, and initiate failure signals.
 - b. Lamp or LED at control module or display panel shall identify status of each controlled circuit.

11. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.
12. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
13. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override.
14. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.
15. Programmed time signals shall change preset scenes and dimmer settings.
16. Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming circuits. Signal shall control dimming of fixture so illumination level remains constant as daylight contribution varies.
17. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

2.04 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
 1. Match color specified in Division 26 Section "Wiring Devices."
 2. Integral green LED pilot light to indicate when circuit is on.
 3. Internal white LED locator light to illuminate when circuit is off.
- B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."
- C. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices."
- D. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."
- E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

PART 3 EXECUTION

3.01 WIRING INSTALLATION

- F. Comply with NECA 1.
- G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- H. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- I. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- J. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
- K. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.02 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Test for circuit continuity.
 - 2. Verify that the control module features are operational.
 - 3. Check operation of local override controls.
 - 4. Test system diagnostics by simulating improper operation of several components selected by Architect.

3.03 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.04 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to 2 visits to Project during other than normal occupancy hours for this purpose.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems.

END OF SECTION

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262213

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.02 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

1.03 CLOSEOUT SUBMITTALS

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

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Match switchboard manufacturer.

2.02 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
 - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.

- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.
 - 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 - 3. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Coil Material: Copper.
 - 2. Internal Coil Connections: Brazed or pressure type.
 - 3. Terminal Connections: Welded.
- D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- E. Enclosure Totally enclosed, nonventilated.
 - 1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 - 4. Finish: Comply with NEMA 250.
 - a. Finish Color: Gray weather-resistant enamel.
- F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- G. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- H. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- I. Wall Brackets: Manufacturer's standard brackets.

2.04 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Secure transformer to concrete base according to manufacturer's written instructions.
- D. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- E. Remove shipping bolts, blocking, and wedges.

3.03 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 - 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

262413
SWITCHBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
 2. Disconnecting and overcurrent protective devices.
 3. Accessory components and features.
 4. Identification.

1.02 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- C. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 6. Detail utility company's metering provisions with indication of approval by utility company.
 7. Include evidence of NRTL listing for series rating of installed devices.
 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 10. Include diagram and details of proposed mimic bus.
 11. Include schematic and wiring diagrams for power, signal, and control wiring.
- D. Delegated Design Submittal:
1. For arc-flash hazard study.
 2. For arc-flash labels
- E. Electrical Room Layout: All electrical rooms (both normal and emergency) and generator rooms have been laid out using dimensional data from specific manufacturers. Submit 1/4" scale drawings of each normal and emergency electrical room (including satellite electrical rooms) or generator room with the actual sizes of all equipment (including fire alarm panels, lighting control panels, contactors, etc.) shown appropriately. For ease of installation, the Contractor may be permitted to rearrange the equipment in each room, provided that all NEC required clearances are maintained and wall space allotted for future equipment is maximized. All submittals must be approved prior to beginning any rough-in work.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Routine maintenance requirements for switchboards and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards.
- C. Handle and prepare switchboards for installation according to NECA 400.

1.05 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

1.06 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.07 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. 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.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Panel mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- I. Nominal System Voltage: 480Y/277 V.
- J. Main-Bus Continuous: As indicated on the plan drawings.
- K. Indoor Enclosures: Steel, NEMA 250, Type 1.
- L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- M. Outdoor Enclosures: Type 3R.
 - 1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
 - 2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
 - 3. Doors: Personnel door at each end of aisle, minimum width of 30 inches; opening outwards; with panic hardware and provisions for padlocking. At least one door shall be sized to permit the largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
- N. Barriers: Between adjacent switchboard sections.
- O. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- P. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

- R. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
 1. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 2. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 3. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 4. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.02 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 6. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.03 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
 - 1. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 2. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
 - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 - 4. Install temporary heating during storage per manufacturer's instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install switchboards and accessories according to NECA 400.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete".
 - 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to switchboards.
 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, surge protection devices, and instrumentation.
1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Comply with NECA 1.

3.03 CONNECTIONS

- A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
- B. Support and secure conductors within the switchboard according to NFPA 70.

3.04 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Provide a 1/2 scale of the "as-built" electrical one-line diagram, with all laminated and mounted under 0.125" thick clear acrylic with a satin finish aluminum frame. All "as-built" comments shall be incorporated into AutoCAD and plotted for this use. Locate drawing adjacent to main switchboard.

3.05 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections]:
1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 2. Test ground-fault protection of equipment for service equipment per NFPA 70.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Switchboard will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.07 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

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262416
PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.02 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- C. All electrical rooms (both normal and emergency) and generator rooms have been laid out using dimensional data from specific manufacturers. Submit 1/4" scale drawings of each normal and emergency electrical room (including satellite electrical rooms) or generator room with the actual sizes of all equipment (including fire alarm panels, lighting control panels, contactors, etc.) shown appropriately. For ease of installation, the Contractor may be permitted to rearrange the equipment in each room, provided that all NEC required clearances are maintained and wall space allotted for future equipment is maximized. All submittals must be approved prior to beginning any rough-in work.

1.03 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing. Coordinate room names to be used in panel schedules with final naming and numbering conventions.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," 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 that allows adjustments.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 certified.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.08 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

1.09 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Manufacturer: Match switchboard manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 2. Height: 84 inches maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 - 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 7. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
- G. Incoming Mains:
 - 1. Location: As required per plan drawings.

2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 1. As indicated on the plan drawings.
- K. Panelboard Short-Circuit Current Rating: Fully rated as indicated on plans to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

2.02 POWER PANELBOARDS

- A. Panelboards: NEMA PB 1, distribution type.
- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 1. For doors more than 36 inches high, provide two latches, keyed alike.
- C. Mains: As indicated on plans.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: As indicated on plans.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 - 6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 - 8. Subfeed Circuit Breakers: Vertically mounted.
 - 9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on and off position.
 - i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.05 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- 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, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.
- M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- N. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.
- F. Provide labels in accordance with the National Electrical Code on each panel that contains series rated equipment.
- G. Provide a 1/2 scale of the "as-built" electrical one-line diagram, with all laminated and mounted under 0.125" thick clear acrylic with a satin finish aluminum frame. All "as-built" comments shall be incorporated into AutoCAD and plotted for this use. Locate drawing adjacent to main service panelboard.

3.04 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.

END OF SECTION

262726

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Straight-blade convenience receptacles.
 - 2. Tamper-resistant receptacles.
 - 3. USB charger devices.
 - 4. GFCI receptacles.
 - 5. Twist-locking receptacles.
 - 6. Pendant cord-connector devices.
 - 7. Cord and plug sets.
 - 8. Toggle Switches.
 - 9. Wall plates.
 - 10. Floor service outlets.

1.02 DEFINITIONS

- A. Abbreviations of Manufacturers' Names:
 - 1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
 - 2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
 - 3. Leviton: Leviton Mfg. Company, Inc.
 - 4. Pass & Seymour: Pass& Seymour/Legrand.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. SPD: Surge protective device.
- E. UTP: Unshielded twisted pair.

1.03 ACTION SUBMITTALS

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

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.01 GENERAL WIRING-DEVICE REQUIREMENTS

- A. 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.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.
- D. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

- E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device- Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.03 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5361 (single), 5362 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).
- B. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; TR8300.
 - b. Hubbell; HBL8300SG.
 - c. Leviton; 8300-SGG.
 - d. Pass & Seymour; TR63H.
 - 2. Description: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.04 USB CHARGER DEVICES

- A. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper.
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.
 - 2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
 - 3. USB Receptacles: Dual, Type A.
 - 4. Line Voltage Receptacles: Dual, two pole, three wire, and self-grounding.

2.05 GFCI RECEPTACLES

- A. General Description:
 - 1. 125 V, 20 A, straight blade, non-feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.

3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; GF20.
 - b. Pass & Seymour; 2084.
- C. Tamper-Resistant, Duplex GFCI Convenience Receptacles:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
 - d. Pass & Seymour

2.06 TWIST-LOCKING RECEPTACLES

- A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; L520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.07 PENDANT CORD-CONNECTOR DEVICES

- A. Description:
 1. Matching, locking-type plug and receptacle body connector.
 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
 4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.08 CORD AND PLUG SETS

- A. Description:
 1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
 3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.09 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

- c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; PS20AC1 (single pole), PS20AC2 (two pole), PS20AC3 (three way), PS20AC4 (four way).
- C. Pilot-Light Switches: 120/277 V, 20 A.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
 - 2. Description: Single pole, with LED-lighted handle, illuminated when switch is off.
- D. Key-Operated Switches: 120/277 V, 20 A.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 - 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - d. Pass & Seymour; 1251.

2.10 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
 - 3. Material for Aquatics Spaces: 0.035-inch-thick, satin-finished, Type 302 stainless steel.
 - 4. Material for Mechanical, Pool Mechanical, and other Unfinished Spaces: Galvanized steel.
 - 5. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.11 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Data Communication Outlet: Blank cover with bushed cable opening.

2.12 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
 - 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION

262813

FUSES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Enclosed switches.
 - 2. Spare-fuse cabinets.

1.02 ACTION SUBMITTALS

- A. See Section 01 3000 – Administrative Requirements, for submittal procedures.
- B. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit [in electronic format suitable for use in coordination software] [and] [in PDF format].
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
 - 4. Coordination charts and tables and related data.

1.04 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.05 FIELD 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Mersen (formally Ferraz Shawmut, Inc.)
 - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 - 1. Type RK-1: 250V, 600V, zero- to 600-A rating, 200 kAIC, time delay.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.03 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted 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 of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Motor Branch Circuits: Class RK1, time delay.
 - 2. Large Motor Branch (601-4000 A): Class L, time delay.

3. Other Branch Circuits: Class RK1, time delay.

3.03 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.04 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

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262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.

1.02 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.03 SUBMITTALS

- A. See Section 01 3000 – Administrative Requirements, for submittal procedures.
- B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1.05 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
 - 3. WARRANTY
- B. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.02 FUSIBLE SWITCHES

- A. Match switchboard manufacturer.
- B. Type HD, Heavy Duty, Single Throw. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 NONFUSIBLE SWITCHES

- A. Match switchboard manufacturer.
- B. Type HD, Heavy Duty, Single Throw. UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.02 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen or Wash Down Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids:
NEMA 250, Type 12.

3.03 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

3.04 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

END OF SECTION

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265119
LED INTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes interior LED luminaires:
 - 1. Materials.
 - 2. Finishes.
 - 3. Luminaire support.

1.02 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. LED: Light-emitting diode.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.03 ACTION SUBMITTALS

- A. See Section 01 3000 – Administrative Requirements, for submittal procedures.
- B. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
- C. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- D. Product Schedule: For luminaires and lamps.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.05 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.
- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.07 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards:
 - 1. ENERGY STAR certified.
 - 2. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 - 3. UL Listing: Listed for damp location.
 - 4. Recessed luminaires shall comply with NEMA LE 4.
 - 5. User Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61.
- C. Lamps dimmable from 100 percent to 1 percent of maximum light output.
- D. Internal driver.
- E. Nominal Operating Voltage: As indicated on plans.
- F. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.02 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.03 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Wires for non-corrosive, humid Spaces: ASTM A 580/A 580M, Composition 316, annealed stainless steel, 8 gage.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.03 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Do not attach luminaires directly to gypsum board.
- G. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
 4. Confirm ceiling duty classification. Provide grid supports and structural supports as required by Code.
- I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.
- D. Aim all adjustable luminaires as directed by the Owner, Architect or Engineer, after all furnishings and artwork have been installed.
- E. Where "tenting" of luminaires is required to maintain the fire rating of a ceiling assembly, the minimal clear area surrounding recessed luminaires shall be 3" on all sides.
- F. Cleaning: All luminaires shall be thoroughly cleaned and clear from dust, paint, construction debris and fingerprints after all other trades are complete, but prior to the date of substantial completion.

END OF SECTION

265619

LED EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
 - 2. Luminaire supports.

1.02 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. Lumen: Measured output of lamp and luminaire, or both.
- E. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.03 ACTION SUBMITTALS

- A. See Section 01 3000 – Administrative Requirements, for submittal procedures.
- B. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaire.
 - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.05 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.
- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.07 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

1.08 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. UL Compliance: Comply with UL 1598 and listed for wet location.
- D. Lamp base complying with ANSI C81.61.
- E. Bulb shape complying with ANSI C79.1.
- F. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- G. Internal driver.
- H. Nominal Operating Voltage: As indicated on plans.
- I. Manufacturers: Refer to Lighting Fixture Schedule on plans for manufacturer and catalog specification information.

2.02 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: 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 relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 2. Provide filter/breather for enclosed luminaires.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.03 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.04 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
1. Sized and rated for luminaire weight.
 2. Able to maintain luminaire position after cleaning and relamping.
 3. Support luminaires without causing deflection of finished surface.
 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

- G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.
- H. Coordinate layout and installation of luminaires with other construction.
- I. Adjust luminaires that require field adjustment or aiming.
- J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.04 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.05 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.06 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- C. Luminaire will be considered defective if it does not pass tests and inspections.
- D. Cleaning: All luminaires shall be thoroughly cleaned and clear from dust, paint, construction debris and fingerprints after all other trades are complete, but prior to the date of substantial completion

END OF SECTION

SECTION 31 0000

EARTHWORK

PART 1 - GENERAL

1.1 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 5000, Temporary Facilities and Controls.
- B. Section 01 5713, Erosion Control.
- C. Section 01 8113, Sustainable Design Requirements.
- D. Section 31 2333, Trenching and Backfilling.
- E. Section 32 1200, Asphalt Concrete Paving.
- F. Section 32 1600, Site Concrete.
- G. Section 32 8000, Irrigation.
- H. Section 32 9000, Planting.
- I. Section 33 0000, Utilities.
- J. Section 33 4000, Storm Drainage Utilities.

1.3 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record and appropriate agencies. Work not so inspected is subject to uncovering and replacement.
- C. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects discovered in their work during or following completion of the project. Correcting of inadequate compaction or moisture content is the sole responsibility of the contractor.

- D. Tests (See Part 3 for Compaction Testing).
- E. Contractor shall be solely responsible for all subgrades built. Failures resulting from inadequate compaction or moisture content are the responsibility of the contractor. Contractor shall be solely responsible for any and all repairs.
- F. All earthwork operations shall be performed in accordance to the latest editions of the State of California Department of Transportation Standard Specifications, the project Geotechnical Engineering Report and with these Specifications.
- G. Any work within street rights-of-way shall be performed in accordance with the requirements of the governmental agencies having jurisdiction and shall not begin until all of those governing authorities have been notified, the scope of work is clearly understood, and the governing authorities have granted any required permits or approvals.

1.4 SUBMITTALS

- A. Refer to Section 01 3300.
- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.

1.5 GUARANTEE

- A. Refer to General Conditions and Section 01 3300.

1.6 REFERENCES AND STANDARDS

- A. California Building Code (CBC), edition as noted on the drawings, as adopted by the California Division of State Architect (DSA).
- B. California Green Building Standards Code, edition as noted on the drawings, as adopted by the California Division of the State Architect (DSA).
- C. General: Site survey, included in the drawings, was prepared by Rolls, Anderson & Rolls, dated June, 2023, and is the basis for data regarding current conditions. While the survey is deemed generally accurate, there may be discrepancies and variations due to elapsed time, weather, etc. Existing dirt grades may vary 0.2 ft. from that shown.
- D. Geotechnical Engineering Report was prepared by NV5. Report is entitled Geotechnical Engineering Investigation Report and is on file with Architect. Soils information is taken from this Report. Contractor is responsible for any conclusions drawn from this data; should he prefer not to assume such risk he is under obligation to employ his own experts to analyze available information and/or to make additional explorations, at no cost to Owner, upon which to base his conclusions. Neither Owner, Soils Engineer nor Architect guarantees information will be continuous over entire site of work.
- E. Site Visitation: All bidders interfacing with existing conditions shall visit the site prior to bid to verify general conditions of improvements. Discrepancies must be reported prior to the bid for clarification.

- F. ANSI/ASTM D698-00 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- G. ANSI/ASTM D1556-00 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- H. ANSI/ASTM D1557-02e2 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- I. ANSI/ASTM D 3017-05 Test Methods for Moisture Content of Soils and Soil-Aggregate Mixture by Nuclear Methods (Shallow Depth).
- J. ANSI/ASTM D 422-63(2007) e1 Test Method for Particle Size Analysis of Soil.
- K. ANSI/ASTM D 4318-05 Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit.
- L. CALTRANS Standard Specifications Section 19.
- M. CAL-OSHA, Title 8, Section 1590 (e).
- N. Any work within the street, highway or right-of-way shall be performed in accordance with the requirement of the governmental agencies having jurisdiction, and shall not begin until all of those governing authorities have been notified.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.8 PROJECT CONDITIONS

- A. Existing civil, mechanical and electrical improvements are shown on respective site plans to the extent known. Should the Contractor encounter any deviation between actual conditions and those shown, he is to immediately notify the Architect before continuing work.
- B. Excavation dewatering may be necessary. Contractor shall provide any and all tools, equipment and labor necessary for excavation dewatering no matter what the source. Dewatering shall be continuous until all site utilities are installed and backfilled.

1.9 EXISTING SITE CONDITIONS

- A. Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.

1.10 ON SITE UTILITY VERIFICATION AND REPAIR PROCEDURES

- A. Ground-breaking requirements:

1. All underground work performed by a Contractor must be authorized by the Owner's Construction Manager prior to start of construction.
2. The Contractor is to obtain and keep the original construction utility site plans on site during all excavation operations. Contractor can contact the Owner's Construction Manager to procure the drawings.

B. Underground Utility Locating:

1. The contractor shall hire an Underground Utility Locating Service to locate existing underground utility pathways in areas affected by the scope of work for excavation.
2. Contractor must use an underground utility locator service with a minimum of 3 years experience. The equipment operator must have demonstrated experience. Contact Norcal Underground Locating (800/986-6722) or Precision Locating (800/577-7324).
3. The Underground Utility Locator Service must have the use of equipment with the ability to locate by means of inductive clamping, induction, inductive metal detection, conductive coupling, or TransOnde (Radio detection) to generate signals, passive locating (free scoping) for "hot" electric, and metal detector.
4. The Underground Utility Locator Service must be able to locate existing utilities at a depth of at least 72".
5. The Underground Utility Locator Service must be able to locate but are not limited to locating the following types of utility pathways:
 - a. All conduit pathways containing 110 volt or greater 50-60Hz electrical wire.
 - b. All conduit pathways containing an active cable TV system.
 - c. All conduit pathways containing wire or conductor in which a signal can be attached and generated without damaging or triggering the existing systems.
 - d. All empty conduit pathways or pipe in which a signal probe or sonde (miniature transmitter) can be inserted.
 - e. All conduit pathways containing non-conductive cables or wires in which a signal probe or sonde (miniature transmitter) can be inserted.
 - f. All plastic and other nonconductive water lines in which a TransOnde Radio detection) or other "transmitter" can be applied to create a low frequency pressure wave (signal) without damaging or triggering the existing systems.
 - g. All copper or steel waterlines and plastic or steel gas lines.
6. All markings made by the Underground Utility Locator Service or other shall be clear and visible.
7. The contractor shall maintain all markings made by Underground Utility Locator Service or other throughout the entire length of the project.
8. The Underground Utility Locator Service shall provide the contractor with two sets of maps showing the location of utilities and average depth. They will be referenced to permanent buildings. Contractor will deliver one copy to the owner at no additional charge.
9. Contractor is responsible to contact Underground Service Alert (U.S.A. 811) and receive clearance prior to any excavation operations.
10. Contractor shall inform the Owner's Construction Manager no later than five (5) days prior to the date scheduled for the utility locator service to be on site.

1.11 PROTECTION

- A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.
- B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. The Contractor shall work in concert per local and state codes to ensure the provision of adequate bracing, shoring, and temporary crossovers for pedestrian and vehicular traffic including guard rails, lamps, warning signs and flags as required by agencies having jurisdiction and as directed by the Owner. Remove same when necessity for protection ceases.
- D. Any damage done by the Contractor to existing structures, utilities, landscaping, etc., shall be repaired by the Contractor at his sole expense in a manner acceptable to the Owner of the damaged property. The Contractor shall report any existing damage prior to his beginning work.
- E. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- F. Provide shoring, sheeting, sheet piles and or bracing to prevent caving, erosion or gulying of sides of excavation. All temporary shoring, bracing, etc., and maintenance thereto required for the completion of earthwork grading operations shall be provided by the Contractor whose work requires protection.
- G. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. The contractor shall make a reasonable effort on a daily basis to keep all excavations and the site free from water during entire progress of work, regardless of cause, source, or nature of water.
- H. The Contractor shall provide all necessary pumps, under drains, well point systems, and other means necessary for keeping the work area dry and for removing water from excavations, trenches, sub-grades and other parts of the work.
- I. Water from excavations shall be disposed of in such a manner as to not cause injury to the public health, to public or private property, to the work completed or in progress, to the surface of streets, or cause any interference with the use of the same by the public.
- J. The Contractor shall restore any pavement or public right-of-way surface that is disturbed by the work under this section. All pavement or surface restoration work in the public right-of-way shall be performed to the full satisfaction of the governmental agencies having jurisdiction.

- K. Natural features such as, but not limited to, trees, existing structures, existing landscaping, etc., which is not subject to changes during earthwork operations by reason of the Drawings and Specifications, shall be protected as required and shall not be defaced or injured in any manner. Provide temporary irrigation as necessary to maintain health of trees and landscaping.
- L. Environmental Requirements:
 - 1. All work shall be performed in accordance with state and local building codes and Environmental Protection Agency (EPA) regulations.
 - 2. Noise producing activities shall be held to a minimum. Internal combustion engines and compressors, etc., shall be equipped with mufflers to reduce noise to a minimum. Comply with all noise abatement ordinances
 - 3. No ground-disturbing activities shall be allowed outside of the project construction boundary. Construction fencing shall be placed at the boundary of the project site to clearly mark the limits of ground-disturbing activities.
 - 4. All project-related traffic shall be restricted to designated access roads, routes, and construction areas within the project boundary. No vehicular or pedestrian traffic shall be allowed outside the designated project boundary.
 - 5. Keep all areas within the construction area sufficiently dampened to prevent dust from rising due to construction. Comply with all anti-pollution ordinances.
 - 6. The Contractor shall insure that trucks leaving the site do not deposit mud and earth on adjacent street pavements. Any mud or earth deposited on street pavements shall be promptly removed by the Contractor.
 - 7. All earthwork operations shall be performed in a manner such as to prevent any run-off of soils from the site into streams and/or storm drainage systems. Appropriate sedimentation ponds, dikes, collars, silt fences, and filter media shall be employed to insure compliance with these requirements. Where a specific statute governs these procedures, such statute shall be complied with in its entirety.

1.12 SEASONAL LIMITS

- A. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by rains, fill operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.
- B. Excessively wet fill material shall be bladed and aerated per Section 3.8, B.

1.13 TESTING

- A. General: Refer to Section 01 4523 - TESTING & INSPECTION SERVICES, AND STRUCTURAL TESTS AND INSPECTIONS LIST, DSA-103.
- B. Geotechnical Engineer: Owner is retaining a Geotechnical Engineer to determine compliance of fill with Specifications, and to direct adjustments in fill operations. Costs of Geotechnical Engineer will be borne by Owner; except those costs incurred for re-tests or re-inspection will be paid by Owner and backcharged to Contractor.

1. If Contractor elects to process or mine onsite materials for use as Suitable Fill, Aggregate Sub Base, Aggregate Base, Rock, Crushed Rock or sand the cost of all testing of this material shall be paid for by the Contractor.
2. Testing of import fill for compliance with Department of Toxic Substance Control (DTSC) shall be paid for by the Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Engineered Fill Materials: All fill shall be of approved local materials supplemented by imported fill if necessary. "Approved" local materials are defined as local soils tested and approved by Geotechnical Engineer and complying with the Geotechnical Engineering Report.
- B. Imported Engineered Fill Material: All Imported fill shall comply with the Geotechnical Engineering Report. All import fill material shall be tested and approved by Soils Engineer prior to transportation to the site. Proposed fill material shall comply with DTSC guidelines to include Phase 1 environmental site assessment and related tests. Refer to the October 2001 DTSC Information Advisory for clean imported fill material.
 1. DTSC TESTING: Site work contractor is to coordinate testing with an analytical lab, hired by the owner, licensed by the State of California for the DTSC testing. The costs associated with testing will be paid by the contractor.
 2. DTSC testing shall include documentation as to the previous land use, location, and history. Soils shall be analyzed for all compounds of concern to ensure the imported soil is uncontaminated and acceptable. Testing shall be performed per the recommendations included in DTSC Imported Fill Advisory [http://www.dtsc.ca.gov/Schools/upload/SMP FS Cleanfill-Schools.pdf](http://www.dtsc.ca.gov/Schools/upload/SMP_FS_Cleanfill-Schools.pdf)). Soils shall be tested prior to import to the project site.
 3. Lab shall determine geographically which tests and analysis comparison will be appropriate for the testing. (CAM 17 / Title 22); (RWQCB) Regional Water Quality Control Board; or (OEHHA) Office of Environmental Health Hazard Assessment.
 4. Frequency of testing shall be conducted in accordance with DTSC's Imported Fill Advisory as follows;

Fill Material Sample Schedule	
Area Of Individual Borrow Area	Sampling Requirements
2 Acres or less	Minimum of 4 samples
2 to 4 Acres	Minimum of 1 sample every ½ acre
4 to 10 Acres	Minimum of 8 samples
Greater than 10 Acres	Minimum of 8 locations with 4 subsamples per location

Volume of Borrow Area Stockpile	
Up to 1,000 Cubic Yards	1 sample per 250 cubic yards
1,000 to 5,000 Cubic Yards	4 samples for the first 1000 cubic yards + 1 sample per each additional 500 cubic yards
Greater than 5,000 Cubic Yards	12 samples for the first 5,000 cubic yards + 1 sample per each additional 1,000 cubic yards

5. Reports/ Documentation

- a. Results of the testing analysis shall be sent to the Owner; Architect; Project Inspector, Project Civil Engineer, DTSC, and DSA. Letter shall reference DSA file and application numbers.

C. Landscape Backfill Material:

- 1. The top 6" of native topsoil stripped from the site may be used for landscape backfill material provided it meets the requirements as specified in Section 32 90 00 Landscape Installation.
- 2. Imported Topsoil may be required to complete work. See Section 32 90 00 Landscape Installation for requirements. Proposed Topsoil material shall comply with DTSC guidelines to include Phase 1 environmental site assessment and related tests. Refer to the October 2001 DTSC Information Advisory for clean imported fill material.

D. Water: Furnish all required water for construction purposes, including compaction and dust control. Water shall be potable.

E. Aggregate Base: Provide Class 2 3/4" Aggregate Base conforming to standard gradation as specified in Caltrans Standard Specifications, Section 26-1.02.

- F. Decomposed Granite: Decomposed Granite shall be well graded mixture of fine to 1/8" particles in size with no clods. The material shall be free of vegetation, other soils, debris and rock. The material shall be redish-tan to tan in color.
- G. Decomposed Granite Solidifier: PolyPavement or equal.

PART 3 - EXECUTION

3.1 INSPECTION LAYOUT AND PREPARATION

- A. Prior to installation of the work of this Section, carefully inspect and verify by field measurements that installed work of all other trades is complete to the point where this installation may properly commence
- B. Layout all work, establish grades, locate existing underground utilities, set markers and stakes, setup and maintain barricades and protection facilities; all prior to beginning actual earthwork operations. Layout and staking shall be done by a licensed Land Surveyor or Professional Civil Engineer.
- C. Verify that specified items may be installed in accordance with the approved design.
- D. In event of discrepancy, immediately notify Owner and the Architect. Do not proceed in discrepant areas until discrepancies have been fully resolved.

3.2 PERFORMANCE

A. GENERAL:

1. General: Do all grading, excavating and cutting necessary to conform finish grade and contours as shown. All cuts shall be made to true surface of subgrade. After completion of the excavation operation, the sub-grade, shall be prepared as required in the project Geotechnical Engineering Report.
2. Archaeological Artifacts: Should any artifacts of possible historic interest be encountered during earthwork operations, halt all work in area of discovery and immediately contact the Architect for notification of appropriate authorities.
3. Degree of Compaction: Percentage of maximum density, hereinafter specified as degree of compaction required, means density equivalent to that percentage of maximum dry density determined by ASTM D1557 Compaction Test method, and such expressed percentage thereof will be minimum acceptable compaction for specified work.
4. Optimum Moisture Content: Optimum moisture content will be determined by the Geotechnical Engineer and this information supplied to Contractor. Optimum moisture content shall be maintained until subgrade is covered by surfacing materials.

3.3 DEMOLITION, DISPOSAL AND DISPOSITION OF UNDESIRABLE MAN-MADE FEATURES

- A. All other obstructions, such as abandoned utility lines, septic tanks, concrete foundations, and the like shall be removed from site. Excavations resulting from these removal activities shall be cleaned of all loose materials, dish shaped, and widened as necessary to permit access for compaction equipment. Areas exposed by any required over-excavation shall be backfilled

as directed by the Geotechnical Engineer and with materials conforming with the Geotechnical Engineering Report.

3.4 TESTING AND OBSERVATION

- A. All grading and earthwork operations shall be observed by the Geotechnical Engineer or his representative, serving as the representative of the Owner.
- B. Field compaction tests shall be made by the Geotechnical Engineer or his representative. If moisture content and/or compaction are not satisfactory, Contractor will be required to change equipment or procedure or both, as required to obtain specified moisture or compaction. Notify Geotechnical Engineer at least 48 hours in advance of any filling operation.
- C. Earthwork shall not be performed without the notification or approval of the Geotechnical Engineer or his representative. The Contractor shall notify the Geotechnical Engineer at least two (2) working days prior to commencement of any aspect of the site earthwork.
- D. If the Contractor should fail to meet the compaction or design requirements embodied in this document and on the applicable plans, he shall make the necessary readjustments until all work is deemed satisfactory, as determined by the Geotechnical Engineer or Architect/Engineer.
- E. After each rain event Geotechnical Engineer shall test fill material for optimum moisture. Do not place any fill material until desired moisture is achieved.
- F. It shall be the Contractor's responsibility to take whatever measures are required to bring any soils areas found to be deficient up to the requirements of the working drawings and specifications.
- G. The contractor shall contact local officials and inspectors to inspect his work where local building codes require construction inspections.

3.5 CLEARING AND GRUBBING

- A. Prior to grading, remove all debris off-site. Remove trees and brush including the root systems. Holes resulting from tree and brush removal should be prepared and backfilled in accordance with Sections 3.7, 3.8, 3.9, and 3.10. This may require deepening and/or widening the holes to adequately remove disturbed soil and provide room for compaction equipment. Strip the surface of all organics. Strippings meeting the requirements of Section 32 9000 may be used in landscape areas only.

3.6 CUTTING

- A. Building pads that are located within a cut/fill transition area will have to be over-excavated to provide a semi-uniform fill beneath the building pad. Cut and fill areas within the building pad footprint shall be excavated, filled and compacted as directed by the Geotechnical Engineer and in accordance with the Geotechnical Engineering Report.
- B. Do all cutting necessary to bring finish grade to elevations shown on Drawings.
- C. When excavation through roots is necessary, cut roots by hand.

- D. Carefully excavate around existing utilities to avoid unnecessary damage. The contractor shall anticipate and perform hand work near existing utilities as shown on the survey, without additional claims or cost.

3.7 STRUCTURAL EXCAVATION

- A. General: Excavate to bear on firm material at contract depth shown on Structural Drawings.
- B. Footings: All footing excavations shall be of sufficient width for installation of formwork, unless earth will retain its position during concreting. All portions of footings above grade must be formed. In the event that footings are placed against earth, footing widths below grade shall be increased 2 inches from those shown on Drawings and positive protection shall be provided for top corners of trench.
- C. Unsuitable Ground: Any errors in structural excavation, soft ground, or clay soils found when excavating shall be reported to Architect. In no case shall work be built on any such soft or clayey unsuitable surface. Restore excavations to proper elevation with engineered fill placed and compacted as directed by the Geotechnical Engineer and in compliance with the Geotechnical Engineering Report.

3.8 SUBGRADE PREPARATION

- A. Grade, compact and finish all subgrades within a tolerance of 0.10' of grades as indicated on Drawings and so as not to pool water. Subgrade within building pads and concrete walks shall be within 0.05' of grades indicated.
- B. After clearing, grubbing and cutting, subsurface shall be plowed or scarified as directed by the Geotechnical Engineer and in accordance with the Geotechnical Engineering Report. Subgrade shall be moisture conditioned and recompacted per the Geotechnical Engineering Report and as determined by ASTM Test Method D1557. If the existing soils are at a water content higher than specified, the contractor shall provide multiple daily aerations by ripping, blading, and/or discing to dry the soils to a moisture content where the specified degree of compaction can be achieved. After seven consecutive working days of daily aerations, and the moisture content of the soil remains higher than specified, the contractor shall notify the architect. If the existing soils have a moisture content lower than specified, the contractor shall scarify, rip, water and blade existing soil to achieve specified moisture content. The contractor shall make proper allowance in schedule and methods to complete this work.
- C. After subgrade for fill within building pad area or within paved areas has been cleared, plowed and scarified, it shall be disked or bladed until uniform and free from large clods and moisture conditioned and compacted in conformance with the Geotechnical Engineering Report.
- D. Subgrade in areas to receive landscaping shall be compacted in conformance with the Geotechnical Engineering Report.
- E. Where Contractor over-excavates building pads through error, resulting excavation shall be recompacted as engineered fill at Contractor's expense.

3.9 PLACING, SPREADING AND COMPACTING FILL MATERIAL IN BUILDING PAD AND PAVEMENT AREAS

- A. Selected fill material shall be placed in conformance with the Geotechnical Engineering Report.
- B. Selected fill material shall be moisture-conditioned in conformance with the Geotechnical Engineering Report.
- C. All fill material shall be compacted as required by the project Geotechnical Engineering Report.
- D. If soft, yielding material is encountered in cuts, or in fills as a result of trapping water, and cannot be satisfactorily stabilized by moisture control and compaction, the unstable material shall be excavated to the depth as directed by the Owner's Representative and the project Geotechnical Engineer. The excavation shall then be filled as required by the project Geotechnical Engineer.
- E. Frozen topsoil shall not be placed nor shall any acceptable topsoil be placed on frozen or snow covered subgrade.
- F. Compaction of the subgrade or fill shall be achieved by the use of sheep's foot rollers, rubber tired rollers, crawler type tractors, vibratory compactors, etc. Type of equipment selected shall be as recommended for the types of soils encountered and compaction levels specified. Equipment shall have the project Geotechnical Engineer's approval.
- G. Artificial drying by the application of lime or other chemicals will not be permitted unless approved by the Owner's Representative and the project Geotechnical Engineer.
- H. Jetting of fill materials will not be allowed.

3.10 FINAL SUBGRADE COMPACTION

- A. Building Pads: Compaction of building pads shall be in conformance with the Geotechnical Engineering Report.
- B. Paved Areas: Compaction of subgrade beneath paved surfaces shall be in conformance with the Geotechnical Engineering Report.
- C. Other Fill and Backfill: All fill material compaction shall conform with the Geotechnical Engineering Report.
- D. Gravel Fill: Do not place compacted gravel fill until after underground work and foundations are in place. All gravel fill shall be placed and compacted in conformance with the Geotechnical Engineering Report.

3.11 PLACING, SPREADING, AND COMPACTION OF LANDSCAPE BACKFILL MATERIALS

- A. All landscaped areas shall receive topsoil. See Section 32 90 00 for additional information.
- B. Project Inspector must verify that materials are uniformly spread to minimum depth specified.

3.12 SLOPE CONSTRUCTION

- A. All cut and fill slopes shall be constructed as directed by the Geotechnical Engineer and in conformance with the Geotechnical Engineering Report.

3.13 FINISH GRADING

- A. At completion of project, site shall be finished graded, as indicated on Drawings. Finish grades shall be "flat graded" to grades shown on the drawing. Mounding of finish grades will not be allowed unless otherwise directed on the drawings. Tolerances for finish grades in drainage swales shall be $\pm 0.05'$. Tie in new and existing finish grades. Leave all landscaped areas in finish condition for lawn seeding. Landscaped planters shall be graded uniformly from edge of planter to inlets. If sod is used for turf areas the finish grade on which it is placed shall be lowered to allow for sod thickness.
- B. Completed graded areas shall be protected from the action of the elements. Any settlement, displacement, or washing out that may occur during construction shall be repaired and grades re-established by the Contractor to the required elevations and slopes.
- C. All landscape areas shall be left free of rock or foreign material as specified in Section 32 90 00.
- D. All landscape areas shall be approved by Architect prior to any planting.

3.14 SURPLUS MATERIAL

- A. Remove from the site and make legal disposition of any excess soils and topsoil, waste, trash or debris. No waste, trash or debris shall be burned or buried on the site as a means of disposal. Excavated material not required for grading or backfill shall be removed from site at contractor's expense.

3.15 CLEANING

- A. Refer to Section 01 7700.
- B. Remove from fill all vegetation, wood, form lumber, casual lumber, and shavings, in contact with ground; buried wood will not be permitted in any fill.

- END OF SECTION -

SECTION 31 1000

SITE CLEARING

PART 1 - GENERAL

1.1 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.2 CODES

- A. The following are minimum requirements and shall govern, except that all local, state and/or federal codes and ordinances shall govern when their requirements are in excess hereof.

1.3 DESCRIPTION

- A. Furnish all materials, labor, equipment, services, etc., necessary and incidental for the completion of all site clearing and removal work as shown on the drawings and as specified herein.
- B. All onsite and offsite work included consists of but is not limited to the following:
 - 1. Removal of existing sidewalks, drives, curbs, pavements, etc. per plans. Trees, shrubs, irrigation. See Abatement Report.
 - 2. Removal and capping off or relocation of existing underground utilities, underground structures, etc. per plans.
 - 3. Removal from site and disposal of all waste, debris and unusable material.
 - 4. Backfill all open excavations created by the removal of underground utilities, underground structures, etc.

1.4 RELATED SECTIONS

- A. Related work specified elsewhere:

- 1. Section 31 0000 – Earthwork.

1.5 QUALITY ASSURANCE

- A. Obtain and pay for any permits, bonds, licenses, etc., required for Site Clearing and Removal work.
- B. All clearing and removal work shall be accomplished in strict accordance with all local and state building codes, requirements and regulations including but not limited to noise abatement, dust control, classification of disposal materials, etc.

- C. Any work within street or highway right-of-way shall be done in accordance with the requirements of the governmental agencies having jurisdiction and shall not begin until these governing authorities have been notified.

1.6 REFERENCES AND STANDARDS

- A. California Building Code (CBC), edition as noted on the drawings, as adopted by the California Division of State Architect (DSA).
- B. California Green Building Standards Code, edition as noted on the drawings, as adopted by the California Division of the State Architect (DSA).
- C. Caltrans Standard Specifications Section 17.
- D. Geotechnical Engineering and Geologic Hazards Report prepared by NV5.

1.7 JOB CONDITIONS

- A. An attempt has been made to show all existing structures, utilities, drives, pavements, curbs, walks, etc. in their approximate location on the survey and/or working drawings. However, others that are not shown may exist and may be found upon visiting the site or during the clearing and removal work. It will be the responsibility of this contractor to accurately locate all existing facilities and to determine their extent. If such facilities obstruct the progress of the work and are not indicated to be removed or relocated, they shall be removed or relocated only as directed by the Owner.
 - 1. Report any existing site element not shown on the working drawings to the Architect of Record so that the proper dispensation of that element may be made.
- B. Natural features, existing structures, existing landscaping, existing utilities, etc. which are indicated to remain on the drawings and specifications shall be protected and shall not be defaced or damaged in any manner.
- C. Restore to their present conditions any pavement in the public right-of-way that is disturbed by the work under this section. All pavement restoration work in public rights-of-way shall be performed to the full satisfaction of the governmental agencies having local jurisdiction.
- D. Traffic: Minimize interference with adjoining 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 the Owner's Representative and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Noise producing activities shall be held to a minimum. Internal combustion engines and compressors, etc., shall be equipped with mufflers to reduce noise to a minimum. Comply with all noise abatement ordinances.

- B. Keep all areas within the clearing and removal area sufficiently dampened to prevent dust from rising due to clearing or removal operations. Comply with all anti-pollution ordinances.
 - 1. The contractor shall see to it that trucks leaving the site shall do so in such a manner that debris, vegetation, mud and earth will not be deposited on adjacent street pavements. Any debris, vegetation, mud or earth deposited on street pavements shall be promptly removed by the contractor.
- C. All clearing and removal operations shall be performed in a manner such as to prevent any wash-off of soils from the site into streams and/or storm drainage systems. Appropriate sedimentation ponds, dikes, silt fences, collars, and filter media shall be employed to insure compliance with these requirements. Where a specific statute governs these procedures, such statute shall be complied with in its entirety.

1.9 PROTECTION AND SHORING

- A. Protect all existing structures, utilities and landscaping indicated to remain on the drawings.
 - 1. All trees, shrubs, and other items, indicated to remain shall be protected during the entire progress of the work. This includes protection of the root system. The trees shall be fenced at the drip line if they are located in or near an area being used for material storage or subject to damage by traffic during construction. Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed. All trimmings shall be done by skilled workman and in accordance with good tree surgery practices. Contractor shall have a California C61 license, allowing him/her to perform D49 tree work. All tree work shall comply with both the American National Standards Institute (ANSI) Standard Practices for Tree Care Operations.
 - 2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
 - 3. Do not excavate within drip line of trees, unless otherwise indicated.
 - 4. Where excavation for new construction is required within drip line of trees, excavation shall be by hand to minimize impact on roots. Contractor shall use care as to keep the damage to the root system to the minimum extent practicable.
 - a. Cover exposed roots with burlap and water regularly.
 - b. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
 - c. Roots 3/4 inch or greater in size encountered during excavation shall be cleanly cut and treated with a sealing agent to reduce loss of moisture to the tree. Roots greater than 1-1/2 inches shall be preserved and protected at the direction of the Owner's Representative.
 - d. Cover exposed roots with wet burlap to prevent roots from drying out. Place backfill in the excavation as soon as possible.
 - e. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by the Owner's Representative.
 - f. Construction vehicles, equipment, or materials shall not be parked or stored within the tree dripline.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Visit the site so that a full understanding of the difficulties and restrictions attending complete clearing of the site and removal of underground tanks and utilities is obtained. Verify the location of all pertinent items.
- B. Verify with sewer department, water company, gas company, electric company, etc. that all existing utilities, services and overhead lines have been deactivated and abandoned prior to beginning removal work. Notify affected utility department or company prior to beginning removal work.
 - 1. Contact the local "USA North" at 811 to locate underground utilities prior to beginning clearing and removal work.

3.2 PREPARATION

- A. Cut drainage swales and provide temporary grading to carry storm water away from clearing area. No storm water will be permitted to stand in open excavations.
- B. Provide, erect and maintain temporary barriers and security devices as required. Protect all existing landscaping, structures, utilities and site elements which are not to be demolished.
- C. Notify all affected utility companies and local authorities and agencies prior to beginning the work.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
 - 2. Notify Owner's Representative not less than two (2) days in advance of proposed utility interruptions.
 - 3. Do not proceed with utility interruptions without written permission from the Owner's Representative.
- D. Identify and tag all existing trees and other landscaping designated to remain.
- E. Identify and locate a permanent stockpile area for topsoil. Verify with Owner Representative and see plans for fill soil stockpile area. Coordinate with Landscape Contractor.
- F. Identify and locate a waste area for temporary storage of removed materials and a permanent topsoil stockpile area.
 - 1. No materials may be buried or burned on the site as a means of disposal.

3.3 PERFORMANCE

- A. The contractor shall be responsible for all clearing, grubbing, removing and disposing of trash and debris and for clearing and stockpiling all topsoil which are within the designated limits of the property, easements and roadway rights-of-way, unless otherwise indicated on the drawings.

- B. Prior to rough grading, storage of construction materials or the installation of any temporary construction facilities, strip areas per plans to be occupied by site improvements.
- C. The contractor shall be responsible for removal of sidewalks, pavements, curbs and gutters, exterior slabs and sidewalks indicated to be removed on plans.
- D. The contractor shall be responsible for removal of all underground utilities, underground structures, etc., according to plans.
- E. Protect any existing structures, utilities and all appurtenances to remain. Prevent movement or settling. Provide bracing and shoring as required.
 - 1. Cease cleaning and removal operations immediately if any existing structure or utility appears in danger. Notify the Owner Representative and Architect. Do not resume operations until directed.
- F. All broken construction material, trash and debris, tree slash, sidewalks, curbs, etc. will be considered "waste" and shall be removed from the site.
- G. "Waste" material shall be removed from the site as soon as possible and shall not be allowed to accumulate. Short-term storage of removed material shall be restricted to previously designated "waste" areas or as directed by the Owner Representative.
 - 1. No burning or burying of "waste" material will be permitted.
- H. Continuously dampen all clearing and removal areas to prevent dust from rising during the operation. Provide hoses and/or water trucks as required.

3.4 FIELD QUALITY CONTROL

- A. The Owner shall retain an independent inspection firm or contact local officials and inspectors at locations where local building codes require special inspections.

3.5 CLEAN UP

- A. Material designated for removal shall become the property of the contractor, and any salvage value therefrom will accrue to the contractor, unless otherwise requested by the Owner's Representative.
- B. Remove from the site and make legal disposition of all waste and debris. No waste or debris shall be burned or buried on the site as a means of disposal.

- END OF SECTION -

**SECTION 312200
GRADING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Rough grading.
- B. Fine grading.

1.02 RELATED REQUIREMENTS

- A. Section 311000 - Site Clearing.
- B. Section 312333 - Trenching and Backfilling.
- C. Section 329119 - Landscape Grading.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Gravel: Excavated on-site.
 - 1. Graded according to ASTM D2487 Group Symbol GW, GP, or SP.
- B. Topsoil: Topsoil excavated on-site. Contractor shall preserve and place existing topsoil and minimize soil compaction where feasible.
 - 1. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.
- C. Topsoil shall be supplemented with imported topsoil where salvaged quantities are insufficient.

Imported Topsoil Requirements

	Minimum	Maximum
Material Passing #10 Sieve	95%	-
Clay	5%	50%
Silt	10%	70%
Sand and Gravel	10%	60%
Organic Matter (by weight)	4%	15%
pH (ASTM D 5268)	6.0	8.0

- D. Imported topsoil provided shall be smooth, uniform, and free of stones 1 inch or larger in any dimension, roots and other extraneous or undesirable material harmful to plant growth. The Contractor shall submit to the Landscape Architect the prospective source for the topsoil at least 1 week prior to time of placement to allow adequate time for inspecting the soil and approving the source. Texture shall be determined by the method described in AASHTO T 88.
- E. Other Fill Materials: See Section 312333

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify survey bench mark and intended elevations for grading areas are as indicated.
- B. Verify the absence of standing or ponding water.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect above- and below-grade utilities to remain.
- D. Provide temporary means and methods to remove standing or ponding water from areas prior to grading.
- E. Protect site features to remain, including but not limited to bench marks and survey control points.

3.03 ROUGH GRADING

- A. Excavate and fill subgrade material to elevations indicated on plans.
- B. Replace displaced subgrade in accordance with Section 312333.
- C. Remove and replace unsuitable materials as specified fill.

3.04 FINE GRADING

- A. Scrape and spread subgrade material uniformly smooth and without disruptions.
- B. Slopes: Transition smoothly to adjacent areas.
- C. See Section 329119 for final compaction.

3.05 SOIL REMOVAL AND STOCKPILING

- A. Stockpile topsoil to be re-used on site; remove remainder from site.
- B. Stockpiles: Use meadow areas on site; pile depth not to exceed 6' feet; protect from erosion.

3.06 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.
- C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 6 inches.
- D. Refer to 329119 - Landscape Fine Grading for complete information and depths for planting.
- E. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- F. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.07 TOLERANCES

- A. Top Surface: Plus or minus 1/2 inch.

3.08 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove unused stockpiled subsoil. Grade stockpile area to prevent standing water.
- C. Leave site clean and raked, ready to receive work.

SECTION 312315
EARTHWORK FOR FOUNDATIONS

PART 1 GENERAL

1.01 QUALIFICATION STATEMENT

- A. This specification Section is based on Owner's geotechnical engineering study, but has not been reviewed by Owner's geotechnical engineering consultant as of the date of publication. This Section is therefore considered to be incomplete and subject to modification prior to its use by Contractor for construction.

1.02 SECTION INCLUDES

- A. General preparatory earthwork, including:
 - 1. Rough grading the site in preparation for building excavations.
- B. Structural earthwork related to support of buildings, including:
 - 1. Excavating for footings, slabs-on-grade, and utilities within the building.
 - 2. Filling, backfilling, and compacting for footings, slabs-on-grade, and utilities within the building.
- C. Other earthwork-related work scope within structural support zone, including:
 - 1. Underslab vapor retarder and installation.

1.03 SECTION EXCLUDES

- A. Section specifically excludes earthwork scope outside building structural support zone; see civil, landscape, and other Drawings, and associated specifications for earthwork requirements outside building structural support zone.

1.04 RELATED INFORMATION

- A. Geotechnical Report: Subsurface sampling and testing, findings and descriptions of subsurface materials encountered, and design recommendations.

1.05 DEFINITIONS

- A. Finish Grade Elevations: Indicated on Drawings.
- B. Subgrade Elevations: Indicated on Drawings.

1.06 REFERENCE STANDARDS

- A. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)).
- B. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- C. ASTM D6913/D6913M - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
- D. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- E. ASTM E1643 - Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- F. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- H. CalEPA (DTSC) - California Environmental Protection Agency-Department of Toxic Substances Control - Information Advisory, Clean Imported Fill Material.

1.07 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate requirements for special foundations and load bearing elements specified in other Sections.

- B. Preinstallation Meeting: Conduct a preinstallation meeting minimum one week prior to the start of the work of this Section; require attendance by all affected installers, and Owner's geotechnical engineering consultant.
 - 1. Discuss all earthwork requirements specified, and document any additional requirements or modified requirements received from Owner and Owner's geotechnical engineer which require a modification of the Contract.

1.08 SUBMITTALS

- A. Samples: Minimum 50 lb sample of each type of fill; submit in air-tight containers to testing laboratory.
- B. Materials Sources: Submit name and location of imported materials source.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction density test reports.
- E. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. Locate stockpiles where designated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

- A. Soil materials, whether from sources on or off site must be approved by Owner's geotechnical engineer as suitable for intended use.

2.02 MATERIALS

- A. Engineered Fill: Subsoil excavated on-site, or non-expansive imported material, complying with specified requirements and approved by Owner's geotechnical engineering consultant.
 - 1. Applications: All structural fill and backfill applications supporting building structure and interior building slabs-on-grade.
 - 2. Imported Fill: Imported soil materials are required to comply with CalEPA (DTSC).
 - 3. Graded and moisture conditioned as specified.
 - 4. Free of organic matter, clay lumps, debris, and other deleterious matter.
 - 5. Maximum Liquid Limit: 15, as measured according to ASTM D4318.
 - 6. Maximum Plasticity Index: 15, as measured according to ASTM D4318.
 - 7. Graded in accordance with ASTM D6913/D6913M, within the following limits:
 - a. 3 inch Sieve (Maximum Rock/Oversized Material): 100 percent passing; limited quantity as specified below.
 - b. 1/2 inch Sieve: 100 percent passing; predominant particle size.
- B. Aggregate Base Rock Layer: Angular crushed stone; free of shale, clay, friable material and debris; complying with Caltrans Class II AB physical properties.
 - 1. Applications: Base layer immediately beneath interior concrete slabs-on-grade.
 - 2. Graded in accordance with ASTM D6913/D6913M, within the following limits:
 - a. 3/4 inch Sieve (Maximum Particle Size): 100 percent passing.
 - b. No. 4 Sieve: 5 percent passing.
 - c. No. 200 Sieve: 0 (Zero) to 3 percent passing.

2.03 ACCESSORIES

- A. Underslab Vapor Retarder: Multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E1745, Class A for puncture resistance characteristics; maximum permeance of 0.01 as measured according to ASTM E96/E96M; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Single ply polyethylene is prohibited.
 - 1. Membrane Thickness: Minimum 10 mil.

2. Seam Tape: Manufacturer's proprietary tape with pressure sensitive adhesive; minimum permeance equal to membrane requirement; 4 inch minimum width.
3. Pipe Boots: Combination of specified membrane and seam tape according to membrane manufacturer's instructions.

2.04 SOURCE QUALITY CONTROL

- A. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- B. If tests indicate materials do not meet specified requirements, change material and retest.
- C. Provide materials of each type from same source throughout the work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect from damage above- and below-grade utilities that remain.
- C. Protect site features to remain, including but not limited to bench marks, survey control points, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.
- D. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.

3.03 ROUGH GRADING

- A. Do not reuse or replace wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- B. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 SOIL REMOVAL AND STOCKPILING

- A. Remove excavated material that is unsuitable for re-use from site.
- B. Stockpile excavated subsoil to be re-used on site; remove remainder from site.
- C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.
- D. Use of explosives is not permitted.

3.05 EXCAVATING

- A. Excavate subsoil required for building pads to a level depth of 12 inches below bottom of deepest foundation footing bearing elevation at each building pad, and to a point 5 feet beyond the building line.
 1. Notify Architect of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
 2. Once building pad excavations have reached specified depth, request observation by Owner's geotechnical engineering consultant to evaluate suitability of exposed soils for subsequent backfilling. Owner's geotechnical engineering consultant may recommend further excavation or other remedial work, which will be provided in writing to Owner and Architect.
- B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored; comply with local, State and Federal regulations for excavation support.
- C. Do not interfere with 45 degree bearing splay of footings and foundations.
- D. Hand trim excavations. Remove loose matter.
- E. Correct areas that are over-excavated and load-bearing surfaces that are disturbed to specified requirements.
- F. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- G. Prepare excavated building pad subgrade areas prior to backfilling; scarify subgrade surfaces to a depth of 8 inches.
 1. Cut out soft areas of subgrade not capable of compaction in place. Backfill with engineered fill.

2. Moisture condition and re-compact subgrade to density equal to or greater than requirements for subsequent fill material, unless otherwise specified.
3. Proof roll compacted subgrade areas to identify soft spots; remediate soft spots by scarifying, moisture conditioning, and recompacting until all subgrade areas comply with specified requirements.
4. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.06 TRENCHING

- A. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored; comply with local, State and Federal regulations for excavation support.
- B. Do not interfere with 45 degree bearing splay of footings and foundations.
- C. Cut trenches wide enough to allow inspection of installed utilities.
- D. Cut out soft areas of subgrade not capable of compaction in place. Backfill with engineered fill.
- E. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- F. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.
- G. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

3.07 BACKFILLING

- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Moisture Content: Maintain moisture content of fill and backfill materials, expressed as a percentage in relation to optimum moisture content, to attain required compaction density.
 1. Class GP, GW, GM, GC, SP, SW, SM, and SC Soils: Plus 3 percent to minus 3 percent of ASTM D1557 optimum moisture content.
 2. Class ML and CL Soils: Plus 2 percent to plus 4 percent of ASTM D1557 optimum moisture content.
 3. Protect moisture content of prepared soil materials from moisture loss at all times.
- E. Fill Lift Thickness:
 1. Engineered Fill: Place and compact material in equal continuous layers not exceeding 8 inches loose depth.
 2. Spread oversized material apart to prevent clustering so that void spaces are not created; subject to observation and approval of Owner's geotechnical engineering consultant.
- F. Slope grade away from building minimum 5 percent in the first 5 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- G. Correct areas that are over-excavated.
 1. All Areas: Use engineered fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.
- H. Compaction Density Unless Otherwise Specified or Indicated:
 1. Density measured according to ASTM D1557.
 2. Engineered Fill Under Building Slabs-on-Grade and Foundations: Minimum 90 percent of maximum dry density.

3.08 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. The paragraphs below identify location, fill material to be used (identified from lower to upper fill type), and compacted thickness of each fill:
 1. Utility Piping, Conduits, and Similar Items Within Building:
 - a. Bedding and Backfill: Use engineered fill.
 - b. Fill up to indicated subgrade elevation.

2. At Interior Slab-on-Grade:
 - a. Use engineered fill.
 - 1) Fill from prepared excavated subgrade elevation to 4 inches below slab-on-grade.
 - b. Use aggregate base rock.
 - 1) Fill 4 inches thick.
 - c. Fill up to indicated slab subgrade elevation.
 - d. Place specified vapor retarder over finished subgrade.
3. At Exterior Side of Foundation Walls:
 - a. Use engineered fill.
 - b. Fill up to indicated finish grade elevations.
4. Fill Under Footings and Foundations:
 - a. Use general fill.
 - 1) Fill minimum 12 inches deep.
 - b. Fill up to indicated footing bearing elevation(s).

3.09 INSTALLATION - VAPOR RETARDER

- A. Install vapor barrier under interior slabs on fill according to manufacturer's instructions, ASTM E1643, and as follows:
 1. Fine grade under slab soils to smooth and level surface prior to installation of slab on grade edge and construction joint forms.
 2. Tamp and level subbase soil materials to within plus zero (0) inches to minus 3/4 inches from required subgrade elevation.
 3. Unroll vapor barrier with longest dimension parallel with direction of pour.
 4. Lap vapor barrier over foundation elements and seal to foundation walls.
 5. Lap joints minimum 6 inches and seal.
 6. Seal all penetrations, including pipes, with specified pipe boots; no penetrations of vapor barrier membrane are permitted except for reinforcing steel and permanent utilities.
 7. Do not disturb or damage vapor barrier while placing concrete. Repair damaged vapor barrier by cutting patches of vapor barrier, overlapping damaged area 6 inches minimum and taping all four side with seal tape.

3.10 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Architect as to remedy.

3.11 FIELD QUALITY CONTROL

- A. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.
- B. Compaction density testing will be performed on compacted fill in accordance with ASTM D6938 and ASTM D1557 as applicable.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with specified compaction standard.
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Tests - General:
 1. Conduct at least one test for each strata of soil on which foundations will be placed, to verify required design bearing capacities.
 2. Prior to start of fill work at building pad, conduct field density tests of bottom of building pad excavation.
 3. Conduct one field density test of top 12 inches of subgrade for every 2,500 square feet of building slab, and as otherwise specified below. Provide additional tests in each compacted fill layer for fills exceeding 12 inches in depth.
 4. Conduct at least one field density test for foundation wall backfill at each lift, and not less than one set of tests for each 50 lineal feet of backfill.
 5. Conduct at least one field density test for each 20 cubic yard of backfill for trenches at each lift, and not less than one set of tests for each 50 lineal feet of trench.

F. Frequency of Tests - Minimum:

1. One (1) test for each 1,500 CY or material change; in accordance with ASTM D1557.
2. One (1) test for each 250 CY; in accordance with ASTM D6938

3.12 PROTECTION

- A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

3.13 MAINTENANCE

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

3.14 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.
- B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.15 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

SECTION 31 2333

TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 5000, Temporary Facilities and Controls.
- B. Section 01 8113, Sustainable Design Requirements.
- C. Section 31 0000, Earthwork.
- D. Section 32 8000, Irrigation.
- E. Section 33 0000, Utilities
- F. Section 33 4000, Storm Drainage Utilities.

1.3 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record and appropriate agencies. Work not so inspected is subject to uncovering and replacement.
- C. Contractor / Installer shall have been in business for five (5) years providing/finishing similar size projects and complexity.

1.4 SUBMITTALS

- A. Refer to Section 01 3300.
- B. Submit Manufacturers data and shop drawings.

1.5 GUARANTEE

- A. Submit fully executed Guarantee for work and materials in this Section per 01 3300.

1.6 REFERENCES AND STANDARDS

- A. California Building Code (CBC), edition as noted on the drawings, as adopted by the California Division of the State Architect (DSA).
- B. California Green Building Standards Code, edition as noted on the drawings, as adopted by the California Division of the State Architect (DSA).
- C. California Plumbing Code (CPC), edition as noted on the drawings.
- D. American Society for Testing and Materials (ASTM);
 - 1. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)); 2012.
 - 2. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
- E. Caltrans Standard Specifications, 2015.
- F. The City of Chico, Improvement Standards, latest edition.
- G. Geologic Hazards and Geotechnical Engineering Report prepared by NV5.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.8 PROJECT CONDITIONS

- A. Contractor shall acquaint himself with all existing site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.
- B. Field verify that all components, backing, etc. by others are installed correctly to proceed with installation of products as herein specified.
- C. Trench dewatering may be necessary. Contractor shall provide any and all tools, equipment and labor necessary for trench dewatering no matter what the source. Dewatering shall be continuous until all site utilities are installed and backfilled.

1.9 PROTECTION

- A. Adequate protection measures shall be provided to protect workers and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur.

Replace trees and shrubs outside building area disturbed by operations. Repair all trenches in grass areas with new sod (seeding not permitted) and "stake-off" for protection.

- B. Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the Architect or Owner is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site.
- D. Provide shoring, sheeting, sheet piles and or bracing to prevent caving, erosion or gullyng of sides of excavation.
- E. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. Keep all excavations free from water during entire progress of work, regardless of cause, source or nature of water.
- F. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork, trenching and backfilling operations.
- G. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance.
- H. Trees: Carefully protect existing trees which are to remain.

1.10 TRENCH SAFETY PROVISIONS

- A. General Contractor shall be solely responsible for safety design, construction and coordination with agencies having jurisdiction. If such plan varies from shoring system standards established by Construction Safety Orders, plan shall be prepared by registered civil or structural engineer.
- B. Nothing herein shall be deemed to allow use of shoring, sloping or protective system less effective than that required by Construction Safety Orders of California State Division of Industrial Safety.
- C. When trenching through paved surface, provide steel trench plates to cover open trenches daily until trenches are backfilled.

1.11 SEASONAL LIMITS

- A. No backfill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, full operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.
- B. Material above optimum moisture shall be processed per Section 31 0000, 3.8, B.

1.12 TESTING

- A. General: Refer to Section 31 0000 – Quality Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill materials: Pipeline and conduit trench backfill as shown on the plans and as specified below.
 - 1. 3/4-inch-minus, washed, crushed rock per the Geotechnical Engineering Report.
 - 2. Native material cleaned and graded per the Geotechnical Engineering Report.
 - 3. Sand shall consist of natural or manufactured granular material, or a combination thereof, free of deleterious amounts of organic material, mica, loam, clay, and other substances not suitable for the purpose intended. Sand shall be such size that 90 percent to 100 percent will pass a No. 4 sieve and not more than 5 percent will pass a No. 200 sieve.
 - 4. Class 2 Aggregate, 3/4 inch maximum: Conforming to the requirements of Section 26-1.02 of the State Standard Specifications
 - 5. Temporary Paving shall conform to Sections 39 and 92 of the State Standard Specifications. Aggregate shall be 1/2 inch maximum size, Type B. Bituminous binder shall consist of SC800 liquid asphalt
 - 6. Lean Concrete Backfill shall consist of a fluid, workable mixture of the following ingredients:

<u>Weights per cubic yard (saturated, surface-dry)</u>		
		<u>Yield, CU. FT.</u>
ASTM C-150 / Type II cement, LB	94	0.48
Concrete sand, LB	1,500	8.84
3/8" by #8 gravel, LB	1,704	10.19
Water, LB	100	1.60
Total air, %	21.8 ± 3.0	5.88
Total		27.00
Water/cement ratio, LBS/LB	1.07	
Concrete unit weight, PCF	125.90	

- B. Water: Furnish all required water for construction purposes, including compaction and dust control. Water shall be potable.
- C. Provide other bedding and backfill materials as described and specified in Section 33 0000, Section 33 4000 and Divisions 22 and 26.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verification of Conditions:
 - 1. Examine areas and conditions under which work is to be performed.

2. Identify conditions detrimental to proper or timely completion of work and coordinate with General Contractor to rectify.

3.2 COORDINATION

- A. General Contractor shall coordinate work as herein specified, in accordance with drawings and as required to complete scope of work with all related trades.
- B. General Contractor to hold a pre-construction meeting, estimate 8 hours, for coordination of all underground utilities phasing and logistics with subcontractors.

3.3 INSTALLATION

- A. Perform work in accordance with pipe manufacturer's recommendations, as herein specified and in accordance with drawings.

3.4 TRENCHING

- A. Notify Owner's representative of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- B. Trench excavation shall consist of the excavation required to install pipelines, manholes, drain inlets, catch basins, flushing holes, cleanouts and associated appurtenances and its cost will not be paid separately but compensation will be included in the price bid for placing pipe.
- C. Make all trench walls vertical or sloped construction, as recommended by the manufacturer of the pipe and as shown on the Plans, and with sufficient width to provide free working space on both sides of trench and around installed item as required for caulking, joining, backfilling, and compacting. Where no manufacturer's recommendations are available, trenches shall be not less than 8 inches or more than 24 inches wider than pipe or conduit diameter.
 1. Where recommended trench widths are exceeded redesign shall be performed, at no increase in cost to the Owner, using stronger pipe or special installation procedures.
 2. Restore all surfaces damaged or cut during excavation to original condition.
- D. The Contractor shall excavate whatever substance encountered to the lines and grades shown on the Plans. All material suitable for use as backfill shall be piled in an orderly manner a sufficient distance from the side of the trench to avoid overloading and to prevent sliding into the trench. The Contractor shall do such grading as is necessary to prevent surface water from entering the excavation.
- E. Where the trench crosses cultivated, residential, or meadow land not in a roadway, the top 2 to 4 inches of soil shall be stripped and stockpiled separately from the balance of the excavated material so that later it may be utilized for surface landscaping.
- F. Carefully excavate around existing utilities to avoid unnecessary damage. The contractor shall anticipate and perform hand work near existing utilities as shown on the survey, without additional claims or cost.
- G. Trench excavation where the existing surface to be excavated is concrete or asphalt concrete shall be cut to neat, straight lines with an approved saw or other means acceptable to the Owner. Concrete or asphalt concrete removal shall be performed without damage to any

portion that is to remain in place. Damage to the existing surface that is to remain in place, shall be repaired to a condition equal to that of the existing surface prior to the beginning of the removal operations. The cost of repairing existing surfaces damaged by the Contractor's operations shall be at the Contractor's expense.

- H. Excavate trench straight and true to line and grade and to a depth below the bottom of the pipe sufficient to provide for pipe bedding material as required. Trenches over-excavated in depth shall be re-filled with suitable materials and compacted to 95% relative compaction.
- I. Except with the specific approval of the Owner's Representative, no more than 200 feet of open trench shall be excavated in advance of layout the pipe. Not more than 50 feet of trench excavation shall remain unbackfilled at the end of each day's work. The remainder of the trench shall be backfilled, compacted, and opened to traffic. Any trench excavation remaining unbackfilled shall be covered with steel plates at the end of each day's work per Section 3.7 of this specification. All operations shall be carried out in an orderly fashion. Backfilling, compacting, and cleanup work shall be accomplished as sections of the pipe installation are approved and vehicle and pedestrian access through the work shall be impeded or obstructed as little as possible.
- J. Excavations for utilities related structures and appurtenances, manholes, drop inlets or similar structures shall be sufficient to leave at least 12 inches clear between the outer structure surface and the face of the excavations. When concrete is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation.
- K. Unsatisfactory material, as determined by the project Geotechnical Engineer, shall be removed and replaced in accordance with the project Geotechnical Engineering Report.
- L. The Contractor shall remove and dispose of all water entering the excavation. Disposal of water shall be done in a manner to prevent damage or nuisance to adjacent properties. Straw bales, sediment traps, or other devices shall be provided to prevent silt and sediment from entering storm drainage facilities. Sufficient pumping equipment shall be provided to maintain the trench in a dry condition during the bedding and initial backfilling of the pipe.
- M. Where depths are not shown on the plans, trench to sufficient depth to give minimum fill above top of installed item measured from finish grade above the utility as follows:
 - 1. Sewer pipe: 36 inches
 - 2. Storm drain pipe: 24 inches
 - 3. Water pipe - Fire Supply: 30 inches
 - 4. Water pipe – Domestic Supply: 36 inches
- N. Contractor shall be solely responsible in setting all lines above to avoid conflicts caused by pipes at the same depth. Where occurring contractor shall relocate most easily moved pipe or utility. Gravity drainage and sanitary sewer take precedent over pressurized systems. In any conflict the gravity flow line shall remain and the pressurized system shall be rerouted as necessary to avoid the gravity system.
- O. Trench excavation shall not interfere with normal 45 degree bearing splay of building foundations.

- P. Remove excavated material that is unsuitable for re-use from the site.
- Q. Remove excess excavated material from site.

3.5 BACKFILL

- A. Trench backfill shall be placed as shown on the Drawings, as specified in the project Geotechnical Engineering Report, City of Chico Standard Details, as specified herein, and per the pipe manufacturer's recommendations. Its cost will not be paid for separately but compensation will be included in the price bid for placing pipe.
- B. General: No backfilling shall be done until the installation to be covered has been inspected and approved for covering. Backfilling shall be carried out in an orderly fashion and, in general, shall be done as soon as approval has been given to cover the pipe. Compaction of the backfill shall proceed simultaneously with backfilling operations. Compaction by jetting or ponding shall not be permitted. All excess backfill material shall be removed from the project and disposed of by the Contractor. The location of the disposal site shall be the responsibility of the Contractor and shall be subject to approval of the Owner. Removal of excess material shall be done immediately following backfilling. Trench backfilling shall be completed immediately following excavation. No trenches shall remain open overnight.

Where trenches cross city streets backfilling shall conform to City of Chico requirements and as specified herein.

- C. Bedding and Covering Pipe: The bed for the pipe shall be final-graded by hand to the line and grade to which the pipe is to be laid, making proper allowance for the thickness of the pipe. The bed shall be hand-raked ahead of the pipe laying operation to remove any stones or lumps which will interfere with smooth and proper bedding. Bell holes shall be hand-dug at the location of the joints and shall be of sufficient size to allow proper making of the joint and to prevent the collar or bell of the pipe from bearing on the bottom of the trench. After the pipe has been laid and approved for covering, backfill shall be placed evenly on both sides of the pipe the full width of the trench. This material shall be placed by hand in layers, moisture conditioned to within ± 3 percentage points of the ASTM D1557 optimum moisture content, and each layer shall be compacted to a minimum relative compaction as specified on the Plans and within the Geotechnical Report based on ASTM D1557 maximum dry density by use of approved tampers. Backfill material shall be placed in layers not more than 8-inches thick. Particular care shall be taken to attain the required compaction in the material supporting the underside of the pipe. Compaction by jetting or ponding shall not be permitted.
- D. Backfill: Backfill and compaction shall be done in accordance with the terms of the City Chico standards, the project Geotechnical Report and as specified herein. The following requirements are minimums and do not relieve the Contractor of the responsibility of complying with any more stringent requirements of the City of Chico standards or the project Geotechnical Report.

The trench shall be backfilled in layers with suitable imported material which may be placed by machine. Material shall be placed in 8-inch thick layers and compacted by machine.

Prior to commencing backfilling operations, the Contractor shall notify the project Geotechnical Engineer of the method of compaction which he intends to use. No method will

be approved until the Contractor has demonstrated, under actual field conditions, that such method will produce the degree of compaction required.

The trench backfill shall be compacted to a relative density as specified on the Plans and within the Geotechnical Report.

- E. Lean Concrete Backfill: Where shown on the Plans, and at locations approved by the Owner's Representative, the trench shall be backfilled with lean concrete backfill from the top of the pipe bedding envelope to the bottom of the trench resurfacing structural section.

Immediately after backfilling, all excess material shall be removed and disposed of in an approved disposal area.

- F. Backfill in Areas Previously Lime or Cement Treated: Where trenching occurs in areas that have been lime or cement treated, Class 2 aggregate bases or approved controlled density backfill material shall be used for the top 12-inches minimum of the trench or thickness shall match the depth of treated material.
- G. Compaction Testing will be performed by the project Geotechnical Engineer or appropriate utility representative and the Owner will bear the cost thereof, except that retests of areas which fail to meet compaction will be charged to the Contractor and deducted from any payment due the Contractor for work performed under terms of the Proposal.

3.6 REMOVAL AND REPLACEMENT OF PAVING AND BASE

- A. Only such paving shall be removed as is necessary to excavate the trench and install the pipe. Cuts at valve vaults and other structures shall be no larger than necessary to install the structure.
- B. Paving shall be replaced in accordance with the Specifications, the City Improvement Standards, and the details shown on the Plans. Pavement shall be replaced in all paved areas, streets and highways as soon as possible after completion of backfilling. In no case shall any section of trench in a paved area, street or highway remain unpaved more than one week from the date that the excavation was made. Where trenches cross roadways, pavement shall be replaced the same day the excavation was made.
- C. Where weather conditions or time preclude placing permanent pavement, temporary pavement will be installed. Temporary paving will consist of a one-inch thick layer of premixed asphaltic surfacing material and shall be installed flush with the existing surface. Temporary pavement shall be maintained in a smooth and uniform condition, and shall be removed prior to placing permanent pavement.
- D. Where base material is required, the aggregate base shall be placed and compacted in one even layer to the depth shown on the Plans, and extending the full width of the trench. Segregation shall be avoided and extra care shall be taken in compacting the base near the sides of the trench. Relative compaction shall be not less than 95 percent.
- E. Edges of existing paving shall be neatly cut along straight lines, and cut edges shall be vertical. All loose pieces or cracked sections of existing paving shall be removed. All vertical edges shall be coated with liquid asphalt-emulsion.

- F. The asphalt concrete shall be spread at a temperature suitable for workability and to a depth that will compact to the required thickness as shown on the Plans. No material shall be spread when the outside temperature is less than 40E Fahrenheit. After spreading, the material shall be thoroughly compacted, smooth, and free of irregularities. Rolling equipment shall consist of power rollers equivalent to tandem rollers weighing not less than 8 tons.

3.7 TEMPORARY PAVING

- A. At the end of the day and prior to opening a roadway to traffic, trenches shall be temporarily paved to provide a smooth riding surface. The paving material may be asphalt concrete or temporary paving, "cut back" or other Owner Representative or the appropriate utility representative approved material.
- B. The Contractor may use non-skid plates to cover trenching when approved by the Owner Representative, City, or the appropriate utility representative. The Contractor shall nail down plates, and at edges. The Contractor shall create and maintain a uniform taper using temporary paving to ensure a smooth traveling surface over the plate.
- C. Temporary paving shall be placed on the completed aggregate base course, constructed per the Drawings and as specified herein and shall be placed such that the compacted thickness is not less than two inches.
- D. Compaction of temporary paving shall be performed using steel wheel rollers or mechanical equipment approved by the Owner Representative, City, or the appropriate utility representative. Compaction by wheel rolling with backhoes or other rubber tire construction equipment shall not be allowed.

3.8 UNSUITABLE MATERIAL/IMPORT

- A. Unsuitable material for trench backfill is defined as soil the project Geotechnical Engineer determines to be:
 - 1. Loose, unstable or yielding, or
 - 2. Unable to be compacted to specified density using ordinary methods at optimum moisture content, or
 - 3. Contains visible or excessive deleterious material as determined by the project Geotechnical Engineer, or
 - 4. Too wet to be properly compacted and circumstances prevent processing suitable in-place drying prior to being used as backfill; or
 - 5. Otherwise unsuitable for planned use.
- B. Trench Unsuitable Material
 - 1. Whenever the bottom of the trench is soft or rocky, or rendered not suitable by the project Geotechnical Engineer for pipe bedding, the unsuitable material shall be removed to a minimum depth of six-inches (6") for pipelines or twelve-inches (12") for manholes or appurtenant structures. Whenever excavated native soil is rendered by the project Geotechnical Engineer to be unsuitable for trench strata backfill, Contractor shall remove and replace with import material approved by the project Geotechnical Engineer.

2. Storm drainage, sewer and water pipelines trench unsuitable material shall be replaced with material subject to approval of the project Geotechnical Engineer.
3. Manhole and appurtenant structures unsuitable material shall be replaced with material subject to approval of the project Geotechnical Engineer.
4. The cost to remove and replace unsuitable bedding material to the above specified depths shall be included in the specific bid item cost. Excavation of unsuitable material beyond these depths, so ordered removed by the project Geotechnical Engineer, will be paid as extra work.
5. The cost to replace unsuitable material rendered unsuitable due to any act or omission of the Contractor or due to inclement weather shall be borne by the Contractor and there will be no compensation therefore.

3.9 TRENCH AND SITE RESTORATION

- A. Finished surface of trenches shall be restored to a condition equal to, or better than the condition as existed prior to excavation work.

3.10 PROTECTION

- A. Protect existing surfaces, structures, and utilities from damage. Protect work by others from damage. In the event of damage, immediately repair or replace to satisfaction of Owner.
- B. During the entire construction period, the Contractor shall protect existing pavement. Track-laying equipment shall be equipped with pavement pads when used on pavement. Any pavement damaged, cracked, or broken by the Contractor's operation shall be removed and replaced to at least the original condition. Damaged pavement shall be restored to the satisfaction of the Owner.
- C. Repair existing landscaped areas to as new condition. Replant trees, shrubs or groundcover with existing materials if not damaged or with new materials if required. Replace damaged lawn areas with sod, no seeding will be permitted.
- D. Replace damaged pavement with new compatible matching materials. Concrete walks to be removed to nearest expansion joint and entire panel replaced. Asphalt to be cut neatly and replaced with new materials.
- E. Any existing materials removed or damaged due to trenching to be returned to new condition.

3.11 SURPLUS MATERIAL

- A. Remove excess excavated material, unused materials, damaged or unsuitable materials from site.

3.12 CLEANING

- A. Refer to Section 01 7700.
- B. Leave unused materials in a neat, compact stockpile.

- C. Contractor will keep the work areas in a clean and safe condition so his rubbish, waste, and debris do not interfere with the work of others throughout the project and at the completion of work.
- D. After completion of work in this section, remove all equipment, materials, and debris. Leave entire area in a neat, clean, acceptable condition.

- END OF SECTION -

SECTION 32 1200
ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.1 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 5000, Temporary Facilities and Controls.
- B. Pertinent Sections specifying Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 01 8113, Sustainable Design Requirements.
- D. Section 31 0000, Earthwork.
- E. Section 31 2333, Trenching and Backfilling.
- F. Section 32 8000, Irrigation.
- G. Section 33 4000, Storm Drainage Utilities.

1.3 QUALITY ASSURANCE

- A. Furnish materials and equipment, and perform work in accordance with Sections 37, 39 and 92 of the State Standard Specifications.
- B. The production of asphalt concrete at a batch plant shall conform to Section 39-1.08 of the State Standard Specifications.
- C. Obtain materials from the same source throughout the duration of the project
- D. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- E. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record or other appropriate agency. Work not so inspected is subject to uncovering and replacement.
- F. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects discovered in their work during or following completion of the project. Correcting inadequate compaction is the sole responsibility of the contractor.

- G. Contractor shall provide verification that asphalt mix temperature meets the requirements of this specification at time of application.
- H. Contractor shall be solely responsible for all subgrades built. Any repairs resulting from inadequate compaction is the responsibility of the contractor.

1.4 SUBMITTALS

- A. Refer to Section 01 3300.
- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.
- C. The Contractor shall submit asphalt paving mix designs and material data to the Owner's Representative for approval. **Facsimile submittals will not be accepted.** Material and/or equipment shall not be fabricated, assembled, or shipped until the mix designs and material data have been approved by the Owner's Representative
- D. CAL-GREEN Submittals:
 - 1. Product Data – VOC Limits: For adhesives, sealants, fillers and primers, documentation including printed statement of VOC contents, comply with limits specified in Section 01 6116.
- E. Guarantee of Contractor/Subcontractor per Article 1.5.

1.5 GUARANTEE

- A. Refer to General Conditions and Section 01 3300.
- B. Submit fully executed Guarantee with submittal package required by Article 1.4.

1.6 REFERENCES AND STANDARDS

- A. California Building Code (CBC), edition as noted on the drawings, as adopted by the California Division of the State Architect (DSA).
- B. California Green Building Standards Code, edition as noted on the drawings, as adopted by the California Division of the State Architect (DSA).
- C. ANSI/ASTM D698-00 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- D. ANSI/ASTM D1556-00 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- E. ANSI/ASTM D1557-02 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- F. ANSI/ASTM D 3017-05 Test Methods for Moisture Content of Soils and Soil-Aggregate Mixture by Nuclear Methods (Shallow Depth).
- G. ANSI/ASTM D 422-63 Test Method for Particle Size Analysis of Soil.

H. ANSI/ASTM D 4318-05 Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit.

I. Caltrans Standard Specifications.

J. CAL-OSHA, Title 8, Section 1590 (e).

K. Any work within the street, highway or right-of-way shall be performed in accordance with the requirement of the governmental agencies having jurisdiction, and shall not begin until all of those governing authorities have been notified.

1.7 DELIVERY, STORAGE AND HANDLING

A. Transport, store and handle in strict accord with the local jurisdiction.

B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.8 PROJECT CONDITIONS

A. Environmental Requirements:

1. Base Course: Do not lay base course on muddy subgrade, during wet weather, or when atmospheric temperature is below 40 degrees F.
2. Asphalt Surfacing: Do not apply asphaltic surfacing on wet base, during wet weather, or when atmospheric temperature is below 50 degrees F.

1.9 EXISTING SITE CONDITIONS

A. Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.

1.10 PROTECTION

A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.

B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.

C. Any construction review of the Contractor's performance conducted by the owner's representative is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

- D. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. The contractor shall make a reasonable effort on a daily basis to keep all excavations and the site free from water during entire progress of work, regardless of cause, source, or nature of water.
- E. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- F. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance. Dust control measures shall be in accordance with the local jurisdiction.

1.11 SEASONAL LIMITS

- A. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by rains, fill operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.

1.12 TESTING

- A. General: Refer to Section 01 4523 – TESTING & INSPECTION SERVICES AND STRUCTURAL TESTS AND INSPECTIONS LIST, DSA-103.
- B. Geotechnical Engineer: Owner is retaining a Geotechnical Engineer to determine compliance of fill with Specifications, and to direct adjustments in fill operations. Costs of Geotechnical Engineer will be borne by Owner; except those costs incurred for re-tests or re-inspection will be paid by Owner and backcharged to Contractor.
- C. All asphalt concrete placement shall be done as directed by the Geotechnical Engineer and in conformance with the Geotechnical Engineering Report.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. VOC Limits for adhesives, sealants, fillers, coatings and primers. Comply with limits specified in related Section.
- B. Provide products conforming to local, State and Federal government requirements limiting the amount of volatile organic compounds contained in the product, for its intended application. If specified product exceeds current requirement, provide conforming product at no additional cost. Provide written confirmation to Architect describing reason for revision and demonstrate compliance of replacement product with specified requirements.

2.2 MATERIALS

- A. Sterilant: Soil sterilizer shall be CIBA GEIGY's Pramamol 25-E, Treflan EC or Thompson-Hayward Casoron.
 - 1. Soil sterilizer shall be applied in strict accordance with manufacturer's instructions.

- B. Base Course Aggregate: State Specifications, Section 26, Class 2 aggregate base (3/4" max.).
- C. Asphalt Binder: Steam-refined paving asphalt conforming to State Specifications, Section 92, viscosity grade PG 64-10. Asphalt binder additives for WMA per Caltrans approved list of manufacturer's.
- D. Liquid Asphalt Tack Coat: Per Caltrans Section 94.
- E. Surface Course Aggregate: Mineral aggregates for Type "A" or "B" asphalt concrete, conforming to State Specification 39-2.02, Type B, 1/2" maximum, medium grading.
- F. Seal Coat: shall be a pre-mixed asphalt emulsion blended with select fillers and fibers such as:
 - 1. "Park-Top No. 302", Western Colloid Products.
 - 2. "Overcoat", Reed and Gram.
 - 3. "Drivewalk", Conoco Oil.
- G. Wood Headers and Stakes: Pressure treated.
- H. Pavement Marking: Colors as directed by Architect. Colors of painted traffic stripes and pavement markings must comply with ASTM D 6628.
 - 1. Waterborne traffic line - colors white, yellow and red, State specification PTWB-01R3.
 - 2. Waterborne traffic line for the international symbol of accessibility and other curb markings – blue, red and green, Federal specification TT-P-1952E.
- I. Precast Concrete Bumpers: 3000 psi at 28 day minimum strength; 48" length unless otherwise indicated; provide with steel dowel anchors and concrete epoxy.
- J. Pavement Epoxy; K-Lite; KtepX-590; Ennis Epoxy HPS2 or an approved equal.
- K. Crack Filler; QPR model CAR08, 10oz asphalt crack filler; Star STA-FLEX Trowel Grade crack filler or approved equal.
- L. Reclaimed Asphalt Pavement (RAP). HMA Type A or Type B may be produced using RAP providing it does not exceed 15% of the aggregate blend.

2.3 MIXES

- A. General: Plant mixed conforming to State Specifications, Section 39, Type "A" or "B", 1/2" maximum, medium grading.
- B. Temperature of Hot Mix Asphalt: Not less than 275 degrees F nor more than 325 degrees F when added to aggregate.
- C. Temperature of Hot Mix Aggregate: Not less than 250 degrees F nor more than 325 degrees F when asphalt is added.

- D. Temperature of Hot Mix Asphalt Concrete: Asphalt shall be not less than 285 degrees at time of application, nor more than 350 degrees. Asphalt not meeting the required temperature shall not be used.
- E. Temperature of Warm Mix Asphalt: Mixing and placement; per the approved manufactures heat range recommendations for mixing and placement.

PART 3 - EXECUTION

3.1 EXAMINATION OF CONDITIONS

- A. Conditions of Work in Place: Subsurfaces which are to receive materials specified under this Section shall be carefully examined before beginning work hereunder, and any defects therein shall be reported, in writing, to the Architect. Work shall not be started until such defects have been corrected. Starting of work shall imply acceptance of conditions as they exist.

3.2 PREPARATION

- A. Sub-Grade: Clean, shape and compact to hard surface free from elevations or depressions exceeding 0.05' in 10' from true plan. Compact per Section 31 2000. Compaction and moisture content shall be verified immediately prior to placement of asphalt. Proof roll subbase in presence of geotechnical engineer prior to placement of aggregate base.

3.3 INSTALLATION

A. Headers:

1. General: Install as edging to asphalt paving, except where adjoining existing pavement, concrete curbs, walks or building.
2. Existing Headers: Remove existing headers where new paving will join existing. Saw cut existing asphalt to provide clean edge.
3. Lines and Levels: Install true to line and grade. Cut off tops of stakes 2-inches below top of header so they will not be visible on completion of job.

B. Asphalt Paving:

1. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
2. Verify gradients and elevations of subgrade and aggregate base grade are correct.
3. Verify the subgrade and aggregate base grade have been compacted to the relative densities shown on the Plans and in these Specifications.
4. Base Course: Install in accord with State Specifications, Section 26. Compact to relative compaction of not less than 95%, ASTM D1557. The material shall be deposited on the subgrade in such a manner as to provide a uniform section of material within five percent tolerance of the predetermined required depth. Deposition will be by spreader box or bottom dump truck to prevent segregation of the material. The material so deposited on the subgrade shall have sufficient moisture which, in the opinion of the Geotechnical Engineer is adequate to prevent excessive segregation. It shall then be immediately spread to its planned grade and cross section. Undue segregation of material, excessive

drifting or spotting of material will not be permitted. If in the opinion of the Geotechnical Engineer, the material is unsuitably segregated, it shall be removed or completely reworked to provide the desired uniformity of the material.

5. Sterilant: Apply specified material at manufacturer's recommended rate. Applicator of sterilant material shall be responsible for determining location of all planter areas. Apply specified material over entire base course area just prior to application of asphalt. Follow manufacturer's printed directions.
6. Liquid Asphalt Tack Coat: Tack Coat shall be grade SC-250 liquid asphalt conforming to the requirements of Section 92-1.02 of the State Standard Specifications Apply as "tack coat" to all vertical surfaces of existing paving, curbs, walks, and construction joints in surfacing against which paving is to be placed.
7. Asphalt Concrete Surface Course:
 - a. Asphalt concrete for parking lot paving operations shall be 1/2-inch maximum size, Type "A" or "B", conforming to the requirements of Section 39 of the State Standard Specifications. The Contractor may produce HMA Type "A" or "B", using Reclaimed Asphalt Pavement (RAP). The Contractor may substitute RAP aggregate for a part of the virgin aggregate in HMA in a quantity not exceeding 15.0 percent of the aggregate blend. HMA produced using RAP must comply with Section 39 of the State Standard Specifications.
 - 1) Final gradation shall be smooth, uniform and free of ruts, humps, depressions or irregularities, with a minimum density of 91% of the theoretical maximum specific gravity determined by California Test Method #309. Maximum variation 1/8 inch in 10' when measured with steel straightedge in any one direction. Test paved areas for proper drainage by applying water to cover area. Correct portions that do not drain properly by patching with plant mix. In no case shall accessible parking spaces or loading and unloading areas exceed 2% slope in any direction.
 - 2) Asphalt material shall be delivered to the project site in a covered condition to maintain acceptable temperature.
 - 3) All equipment used for the transporting, spreading, and compacting of asphalt concrete shall conform to Sections 39 of the State Standard Specifications.
 - 4) Asphalt concrete shall be placed, spread and compacted in conformance with the provisions of Section 39-2.01, "Method Construction Process," of the State Standard Specifications. Asphalt concrete shall be spread in one operation with a self-propelled spreader ready for compaction without further shaping. Asphalt concrete shall be placed in maximum 0.25-foot thick compacted layers.
 - 5) Spread Type "A" or Type "B" asphalt concrete at the atmospheric and surface temperatures shown in Section 39 of the State Standard Specifications.
 - 6) Each paver spreading Type "A" or Type "B" asphalt concrete must be followed by 2 rollers as follows:
 - a) One vibratory roller specifically designed to compact HMA. The roller must be capable of at least 2,500 vibrations per minute and must be equipped with amplitude and frequency controls. The roller's gross static weight must be at least 7.5 tons.

- b) One steel-tired, 2-axle tandem roller. The roller's gross static weight must be at least 7.5 tons.
 - c) Each roller must have a separate operator. Rollers must be self-propelled and reversible.
- 7) The compacted finish grade of asphalt concrete at existing and proposed gutters shall be a minimum of 0.01 feet and a maximum of 0.02 feet above the lip of gutter. In no case shall the asphalt concrete be lower than the lip of the gutter.
8. Prior to applying asphalt concrete, the Contractor shall cover all manholes, valve and monument covers, grates, or other exposed facilities located within the area of application, using a plastic or oil resistant construction paper secured to the facility being covered by tape or adhesive. The covered facilities shall be referenced by the Contractor, with a sufficient number of control points to relocate the facilities after the asphalt concrete has been placed. After completion of the paving operation, all covers shall be removed and disposed of in a manner satisfactory to the Owner's Representative. Full compensation for covering manholes, valve and monument covers, grates, or other exposed facilities, referencing, and removing temporary cover shall be considered as included in the contract price and no additional compensation will be allowed.
9. Water Testing: All paved areas shall be water tested, to check drainage, in the presence of the project inspector prior to placement of seal coat. The surface of asphalt paving shall not vary more than 1/8 inch above or below the grade established on the plans. If variations in grade are present, they will be corrected by overlaying paving and/or pavement removal and replacement as directed by the Architect.
10. Patching: Cut existing paving square and plumb at all edges to be joined by new paving. In trenches; grind existing asphalt on each side of trench 3" wide x 1/2 the depth of the section. Apply tack coat to vertical surfaces before installing new work. Warp carefully to flush surface, with seal over joints, and feather edge. Sawcut, remove and patch existing paving where cutting is necessary for installation of piping or conduits under Divisions 15, 16 and 33.
11. Seal Coat:
- a. Seal coat shall be applied no sooner than 30 days from time of asphalt placement.
 - b. Surface Preparation: surface shall be clean of all dirt, sand, oil or grease. Hose down entire area with a strong jet of water to remove all debris. Remove soft, loose, or otherwise damaged areas of asphalt concrete to full depth of damage and replace with compacted asphalt concrete as specified herein. Minor holes and imperfections may be patched using hot mix asphalt or mastic using sand/SS-1-H. Use wire brush for removal of oil and grease; prime with shellac or synthetic resin as recommended by manufacturer of pavement sealer material.
 - c. Seal Coat Seal Application: Thoroughly mix materials in the presence of the onsite inspector. Failure to do so will be cause for rejection. Apply in accordance with manufacturer's written instructions.
 - d. Clean-Up and Precautions: As recommended by pavement sealer material manufacturer.
- C. Pavement Marking: painted pavement markings shall be done only after the seal coat has thoroughly dried. On clean surfaces to be painted with traffic paint of dust, dirt, grime, oil, rust or other contaminants which will impair the quality of work or interfere with proper bond of paint coats. Surfaces shall be cleaned to the extent and by whatever means that will

satisfactorily accomplish the purpose without damage to asphalt concrete. Provide measured layouts, temporary markings, templates, and other means necessary to provide required marking. Prepare and apply paint in accordance with manufacturer's instructions; paint shall be applied by spray and shall achieve complete coverage free from voids and thin spots. Where indicated on the Drawings, paint parking stall stripes, lettering, arrows, accessible symbols, playground markings, game striping, maps, etc. on concrete paving or asphalt concrete paving. Paint stripes shall be 4 inches wide (except otherwise indicated) and applied with two (2) coats of herein specified Traffic Line Paint; white (except as otherwise specified or indicated).

1. International Accessible Symbol: Symbol shall be white figures on a blue background. Blue shall be equal to color No. 15080 in Fed. Std. 595a. Lines and symbols shall be accurately formed and true to line and form; lines shall be straight and uniform in width. Painted edges shall be clean cut and free from raggedness, and corners shall be cut sharp and square. Tolerances: Apply striping within a tolerance 1/2 inch in 50 feet. Apply markings and striping to widths indicated with a tolerance of 1/4 inch on straight sections and 1/2 inch on curved sections.

D. Colors: As directed by Architect

E. Precast Concrete Bumpers: Install where shown, using steel dowels, and epoxy applied for length to wheel stop without damage to bumpers or asphalt concrete paving.

3.4 CLEANING

- A. Upon completion of work of this Section promptly remove from the working area all scraps, debris and surplus material of this Section.
- B. Clean excess material from surface of all concrete walks and utility structures.

- END OF SECTION -

**SECTION 321313
CONCRETE PAVING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete sidewalks, stair steps, integral curbs, gutters, median barriers, parking areas, and roads.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
- B. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.
- C. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- E. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- F. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2023.
- G. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.
- H. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2023.
- I. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2019.
- J. ASTM D8139 - Standard Specification for Semi-Rigid, Closed-Cell Polypropylene Foam, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction; 2023.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, and curing compound.
- C. Design Data: Concrete mix design.
- D. Mock-Ups
 1. Provide mock-up for each type of concrete.
 2. Mock-up shall include entire system, including sub-base, reinforcement, dowel type and placement, control joints, expansion/isolation joints and surface treatments.
 3. Size 10' SQ. MIN.
 4. Notify Landscape Architect seven days in advance of dates and time when mock-ups will be constructed
 5. Obtain from Landscape Architect approval of mock-ups before starting construction.
 6. If the Landscape Architect determines that the mock-ups do not meet requirements, General Contractor will demolish and remove them from the site and arrange to assemble more until approved.
 7. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed work.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish concrete paving work.

- B. Form Materials: Plywood, wood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for all curves with a radius. For all curved pavement with a radius of 100 feet or less, set forms using a center pivot point and a flexible tape measure to swing a uniform arc.
- C. Formwork Accessories
 - 1. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
 - a. Composition: Colorless, reactive, water-based or solvent-based compound.
 - b. Do not use materials containing diesel oil or petroleum-based compounds.

2.02 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) yield strength; deformed billet steel bars; unfinished.
- B. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.

2.03 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: Provide in accordance with South Dakota DOT Standard Specifications for Roads and Bridges.

2.04 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1, Class A.
- B. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
 - 1. Material: ASTM D8139, semi-rigid, closed-cell polypropylene foam.

2.05 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI PRC-211.1 recommendations.
- B. Concrete Strength: Establish required minimum strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Landscape Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended by manufacturer.
- D. Concrete Properties:
 - 1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 4000 psi.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Cement Content: Minimum 600 lb per cubic yard.
 - 4. Water-Cement Ratio: Maximum 42 percent by weight.
 - 5. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
 - 6. Maximum Slump: 3 inches.

2.06 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

- B. Verify gradients and elevations of base are correct.

3.02 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.

3.03 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.04 REINFORCEMENT

- A. Place reinforcement as indicated.

3.05 COLD AND HOT WEATHER CONCRETING

- A. Follow recommendations of ACI PRC-305 when concreting during hot weather.
- B. Follow recommendations of ACI PRC-306 when concreting during cold weather.
- C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.06 PLACING CONCRETE

- A. Place concrete in accordance with State of California Public Works standards.
- B. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- C. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.07 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Place 1/2 inch wide expansion joints at 35 foot intervals and to separate paving from vertical surfaces and other components.
 - 1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
 - 2. Secure to resist movement by wet concrete.
- C. Provide sawn scored or sawn joints.
 - 1. At locations as indicated on plans.
- D. Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/4 minimum into depth of slab.

3.08 FINISHING

- A. Pool Deck Paving: Light broom, spin pattern.
- B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.
- C. Curbs and Gutters: Light broom, texture parallel to pavement direction.
- D. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.09 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.

3.10 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
 - 1. Provide free access to concrete operations at project site and cooperate with appointed firm.
 - 2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 - 3. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
 - 1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 - 2. Perform one slump test for each set of test cylinders taken.
- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.11 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian or vehicular traffic over pavement until 75 percent design strength of concrete has been achieved.

**SECTION 321443
POROUS UNIT PAVING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Porous pavement system.

1.02 RELATED SECTIONS

- A. Section 310000 - Earthwork
- B. Section 328000 - Irrigation
- C. Section 329219 - Seeding
- D. Section 329223 - Sodding
- E. Section 329300 - Plants
- F. Section 334000 - Storm Drainage Utilities

1.03 REFERENCES

- A. ASTM F 1951-08 Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.
- B. ASTM D 638-10 Standard Test Method for Tensile Properties of Plastics
- C. ASTM C 33 Standard Specification for Concrete Aggregates
- D. AASHTO M6 Standard Specification for Fine Aggregate for Hydraulic Cement Concrete

1.04 SYSTEM DESCRIPTION

- A. The Grasspave2 porous pavement system provides vehicular and pedestrian load support for grass areas, while protecting grass roots from harmful effects of traffic.
- B. Major Components of the Complete System:
 - 1. Grasspave2 units, assembled in rolls.
 - 2. Engineered sand and gravel base course.
 - 3. Hydrogrow soil amendment and fertilizer, supplied with Grasspave2.
 - 4. Sand fill or USGA greens mix.
 - 5. Selected grass from seed, hydroseeding/hydro-mulching, or sod.
- C. The Grasspave2 grass paving units, sand, and base course work together to support imposed loading.
- D. The Grasspave2 grass paving units, Hydrogrow, and sand fill contribute to vegetation support.

1.05 SUBMITTALS

- A. Submit under provisions of Section 013000.
- B. Shop Drawings: Submit design detail showing proper cross-section.
- C. Samples: Submit manufacturer's sample of Grasspave2 10 inch x 10 in section of Grasspave2 material.
- D. Installation Instructions: Manufacturer's printed installation instructions. Include methods for maintaining
- E. Certificates:
 - 1. Manufacturer signed certificate stating the product is made in the USA.
 - 2. Submit Material Certificates for base course and sand (or USGA mix) fill materials.
 - 3. Product certificates signed by the manufacturer certifying material compliance of polyethylene used to make Grasspave2 units.
 - 4. ISO Certificate certifying manufacturer's quality management system is currently registered to ISO 9001:2008 quality standards.

- F. Product manufacturers shall also have a minimum of 20 years' experience producing products for porous pavement systems.
- G. Manufacturer Quality Certification: ISO Certification certifying manufacturer's quality management system for its Grasspave2 system is currently registered to ISO 9001:2008 quality standards. Any alternate materials submitted shall provide a certification that their porous pavement system manufacturing process is part of an ISO program and a certification will be required specifically stating that their testing facility is certified and in accordance with ISO.

1.06 DELIVERY, STORAGE, & HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect Grasspave2 units/rolls from damage during delivery and store rolls upright, under tarp, to protect from sunlight, when time for delivery to installation exceeds one week.
- C. Store Hydrogrow in a dark and dry location.
- D. Handling: Protect materials during handling and installation to prevent damage.

1.07 MAINTENANCE SERVICE

- A. Notes: Once healthy turf has been established, the cell wall structure will have minimal visibility when proper turf maintenance practices are followed.
 - 1. Installer responsible for maintenance of grass plants – water/irrigation, fertilizing, mowing – for one growing season. DO NOT AERATE. See Grasspave2 Maintenance Guide from Invisible Structures.

1.08 PROJECT CONDITIONS

- A. Maintain environmental conditions within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not begin installation of porous pavements until all hard surface paving adjacent to porous pavement areas, including concrete walks and asphalt paving, is completed.
- C. Install turf when ambient air temperatures is at least 55 degrees Fahrenheit.
- D. In cold weather, do not use frozen materials or materials mixed or coated with ice or frost, and do not build on frozen base or wet, saturated or muddy subgrade.
- E. Protect partially completed paving against damage from other construction traffic when work is in progress.
- F. Adequately water sod or grass seed to assure germination of seed and growth of root system.
- G. Grass coverage on the sand-filled Grasspave2 rings must be completed within one week: See Part 3 Execution.
- H. DO NOT DRIVE, PARK ON, or use Grasspave2 system for two or three mowing cycles until grass root system has matured (about 3 to 4 weeks for sod or 6 to 8 weeks for seeded areas). Any barricades constructed must still be accessible by emergency and fire equipment during and after installation.

1.09 LIMITED WARRANTY

- A. Invisible Structures, Inc. (ISI) warrants to its purchasers that all products furnished by ISI will be free from defects in material and/or workmanship
- B. This warranty shall be extended for a period of five (5) years following the date of shipment by ISI.
- C. Providing a written claim is presented to ISI within the warranty period and after inspection by ISI showing the materials have failed under this warranty, all defective materials shall be refurbished under this warranty, at no charge, excluding re-installation costs. This in lieu of all other warranties expressed or implied and is the sole warranty extended by ISI.

- D. Our liability under this warranty is limited to the refurbishing of materials and does not include any responsibility for incidental, consequential, or other damages of any nature.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Invisible Structures, Inc., which is located at: 3510 Himalaya Rd. Suite 200; Aurora, CO 80011; Tel: 303-233-8383; Web: www.invisiblestructures.com.
- B. Substitutions: Not permitted.

2.02 GRASSPAVE2

- A. Composition:
1. Manufactured in the USA.
 2. High density polyethylene (HDPE): 100 percent recycled materials.
 3. Color: Black
 4. Color Uniformity: Uniform color throughout all units rolls.
 5. Carbon Black for ultraviolet light stabilization.
 6. Hydrogrow soil amendment and fertilizer, provided by manufacturer with Grasspave2.
- B. Performance Properties:
1. Maximum Loading Capability: 15,940 psi when filled with sand.
 2. Wheelchair Access testing for ADA Compliance: Passing ASTM F 1951-08.
 3. Wheelchair Access testing for ADA Compliance: Passing Rotational Penetrometer testing.
 4. Tensile strength, pull-apart testing: 458 lbf/in from ASTM D638 Modified.
 5. System Permeability (Grasspave2, sand, base course): 2.63 to 38.55 inches of water per hour.
 6. Effective Imperviousness (E.I.): 10%.
- C. Dimensions (individual units are assembled and distributed into rolls):
1. Roll area: From 108 sq ft (10 sq m) to 538 sq ft (50 sq m), in 108 sq ft (10 sq m) increments
 2. Roll Widths: From 3.3 feet to 8.2 feet, in 1.6 feet increments.
 3. Roll Lengths: From 32.8 feet to 65.6 feet, in 3.3 feet increments.
 4. Roll Weights: From 41 lbs (19kg) to 205 lbs (93kg), in 41 lbs (19 kg) increments.
 5. Unit Nominal Width by Length: 20 inches by 20 inches (0.5 m by 0.5 m) or 40 inches by 40 inches (1 m by 1 m).
 6. Nominal Depth: 1 inch – for rolls and individual units.
 7. Unit Weight: 18 oz (510 g) or 5 lbs. (2.27 kg).
 8. Volume Solid: 8 percent

2.03 SYSTEM MATERIALS

- A. Notes: All measurements are subject to manufacturing tolerances, unless otherwise specified.
- B. Base Course: Sandy gravel material from local sources commonly used for road base construction (recycled materials such as crushed concrete or crushed asphalt are NOT acceptable). Conforming to the following sieve analysis and requirements:
1. Sieve analysis and requirements
 - a. 100 percent passing sieve size 1 inch.
 - b. 80-100 percent passing sieve size 3/4 inch.
 - c. 60-80 percent passing sieve size 3/8 inch.
 - d. 40-60 percent passing sieve size #4.
 - e. 25-40 percent passing sieve size #10.
 - f. 5-25 percent passing sieve size #40.
 - g. 0-5 percent passing sieve size #200.
 2. Provide a base course material nearly neutral in pH (range from 6.5 to 7.2) to provide adequate root zone development for turf.

3. Material may be either "pit run" or "crusher run." Avoid using clay based crusher run/pit run. Crusher run material will generally require coarse, well-draining sand conforming to AASHTO M6 to be added to mixture (20 to 30 percent by volume) to ensure long-term porosity.
4. Alternative materials such as crushed shell, limerock, or crushed lava may be used for base course use, provided they are mixed with sharp sand (20 to 30 percent) to ensure long-term porosity, and are brought to proper compaction. Without added sand, crushed shell and limerock set up like concrete and become impervious.
 - a. Alternative size and/or composition of base course materials should be submitted to Invisible Structures, Inc. (Manufacturer) for approval.
 - b. Acceptable alternate base: AASHTO #57 stone mixed with clean, sharp sand (ASTM C- 33) at a rate of 70% stone to 30% sand for full depth of base.
- C. Sand Fill for Rings and Spaces Between Rings: Clean sharp sand (washed concrete sand). Choose one of the following:
 1. Coarse, well-draining sand, such as washed concrete sand conforming to AASHTO M6 or ASTM C-33.
 2. United States Golf Association (USGA) greens, section - sand mix "The Root Zone Mixture."
- D. Turf Conditioner:
 1. Hydrogrow a proprietary soil amendment manufactured by Invisible Structures, Inc. and provided with Grasspave2.
 2. NO SUBSTITUTIONS.
- E. Grass:
 1. Sod: See Sod Specified in 329223. Use 0.51 inch thick (soil thickness) rolled sod from a reputable local grower. Species should be wear resistant, free from disease, and in excellent condition. Sod shall be grown in sand or sandy loam soils only. Sod grown in soils of clay, silt, or high organic materials such as peat, will not be accepted.
 - 2.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine subgrade and base course installed conditions. Do not start porous paving installation until unsatisfactory conditions are corrected. Check for improperly compacted trenches, debris, and improper gradients.
- B. For fire lane installations: prior to installing base course for turf paving, obtain approval of local fire authorities of sub-base.
- C. Start of installation constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found unsatisfactory, contact Architect for resolution.

3.02 PREPARATION

- A. Subgrade Preparation:
 1. Prepare subgrade as specified in Section 310000. Verify subgrade in accordance with porous paving system manufacturer's instructions.
 2. Proper subgrade preparation will enable the Grasspave2 rolls/units to connect properly and remain level and stationary after installation
 3. Excavate area allowing for unit thickness, the engineered base depth (where required), and 0.5 inch for depth of sod root zone or topsoil germination area (when applicable).
 4. Provide adequate drainage from excavated area if area has potential to collect water, when working with in-place soils that have poor permeability.
 5. Ensure in-place soil is relatively dry and free from standing water.
 6. Uniformly grade base.
 7. Level and clear base of large objects, such as rocks and pieces of wood.

- B. Base Preparation:
1. Install Base to a depth of 12" MIN. Verify engineered base (if required) is installed in accordance with porous paving system manufacturer's instructions.
 - a. Heavy Fire Truck & H-20 Loading, Infrequent Passes, CBR 2-4: 12" MIN Depth.
 - b. Heavy Fire Truck & H-20 Loading, Infrequent Passes, CBR 4+: 10"-12" MIN Depth.
 2. Coordinate base installation and preparation with subdrains specified in Section 334000.
 3. If required, place a geotextile separation layer between the natural ground and the 'engineered base'.
 4. If required, install the specified sub-drain and outlet according to construction drawings.
 5. Coordinate base installation and preparation with irrigation and drip irrigation lines specified in Section 328000.
 6. Place engineered base in lifts not to exceed 6 inches, compacting each lift separately to 95 percent Modified Proctor.
 7. Leave 1 inch of depth below final grade for porous paver unit and sand fill and 0.5 inch for depth of sod root zone or topsoil germination area (when applicable).

3.03 HYDROGROW INSTALLATION

- A. Spread all Hydrogrow mix provided (spreader rate = 4.53 kg per 100 m² (10 lbs per 10762 feet) evenly over the surface of the base course with a hand-held, or wheeled, rotary spreader.
- B. The Hydrogrow mix should be placed immediately before installing the Grasspave2.

3.04 GRASSPAVE2 INSTALLATION

- A. Install the Grasspave2 units by placing units with rings facing up, and using snap-fit connectors, pegs and holes, provided to maintain proper spacing and interlock the units. Units can be easily shaped with pruning shears or knife. Units placed on curves, slopes, and high traffic areas shall be anchored to the base course, using 40d common nails with fender washer, as required to secure units in place. Tops of rings shall be between 0.24 inch to 0.51 inch below the surface of adjacent hard-surface pavements.
- B. Install sand in rings as they are laid in sections by "back-dumping" directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or wide "asphalt rakes" to fill the rings. A stiff bristled broom should be used for final "finishing" of the sand. The sand must be "compacted" by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 0.24 inch above top of rings.

3.05 INSTALLATION OF GRASS

- A. Grass coverage on the sand-filled rings must be completed within one week. Sand must be re-installed and leveled and Grasspave2 checked for integrity if rings become exposed due to wind, rain, traffic, or other factors.
- B. Install thin sod directly over sand filled rings, filled no higher than the top of the rings. Sod strips should be placed with very tight joints. Sodded areas must be fertilized and kept moist during root establishment (minimum of 3 weeks). DO NOT DRIVE ON SYSTEM: Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated and established well below the Grasspave2 units.
- C. An alternate method, if approved by the landscape architect: Hydroseeding/hydro-mulching - A combination of water, seed and fertilizer are homogeneously mixed in a purpose-built, truck-mounted tank. The seed mixture is sprayed onto the site at rates shown on plans and per hydroseeding manufacturer's recommendations. Coverage must be uniform and complete. Following germination of the seed, areas lacking germination larger than 0.66 feet x 0.66 feet must be reseeded immediately. Seeded areas must be fertilized and kept moist during development of the turf plants. DO NOT DRIVE ON SYSTEM: Hydroseeded/hydro-mulch areas must be protected from any traffic, other than emergency vehicles, for a period of 6 to 8 weeks, or until the root system has penetrated and established well below the Grasspave2 units.

- D. An second alternate method, if approved by the landscape architect, Install grass seed at rates per grass type. A light "dusting" of commercial topsoil mix, not to exceed 1/2in (0.98 inch) will be placed above the rings and seed mix to aid germination rates. Seeded areas must be fertilized and kept moist during development of the turf plants. **DO NOT DRIVE ON SYSTEM:** Seeded areas must be protected from any traffic, other than emergency vehicles, for a Period of 6 to 8 weeks, or until the root system has penetrated and established well below the Grasspave2 units.
- E. Adequately water sod or grass seed to assure germination of seed and growth of root system.

3.06 PROTECTION

- A. Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated below the Grasspave2 units.

3.07 FIELD QUALITY CONTROL

- A. Remove and replace segments of Grasspave2 units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.
- B. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

3.08 MAINTENANCE

- A. Maintain grass in accordance with manufacturer's instructions and as specified in Section 329223 - Sodding.
- B. Lawn Care: Normal turf care procedures should be followed, including de-thatching.
- C. **DO NOT AERATE.** Aerator will damage the Grasspave2 units. Aeration is not necessary in a sand root zone.
- D. When snow removal is required, keep a metal edged plow blade a minimum of 3/4 inch (0.67 inch) above the surface during plowing operations to avoid causing damage to the Grasspave2 units, or
 1. Use a plow blade with a flexible rubber edge, or
 2. Use a plow blade with skids on the lower outside corners set so the plow blade does not come in contact with the units

**SECTION 321540
LANDSCAPE BOULDERS**

PART 1 GENERAL

1.01 SECTION INCLUDED

- A. This section specifies the requirements for the supply, delivery, and installation of landscape boulders of varying sizes to be used for decorative and functional landscape features. The boulders shall vary in size from 3 feet in diameter to 4 feet in diameter and be installed as specified in the project drawings.

1.02 QUALITY ASSURANCE

- A. All boulders provided shall be free of defects such as cracks or fractures that could affect their stability or aesthetic appearance.
- B. Boulders shall be sourced from an approved quarry or supplier to ensure uniformity in quality, color, and texture.

PART 2 PRODUCTS

2.01 LANDSCAPE BOULDERS

- A. Size Range: Boulders shall vary in size, with diameters ranging from 3 feet to 4 feet. The size and shape of each boulder will be selected based on the design intent and to create a natural, visually pleasing effect.
- B. Weight: Each boulder shall weigh a minimum of 1,500 pounds to ensure stability when placed.
- C. Shape: Boulders should be generally round, angular, or irregular in shape, providing a natural appearance and texture. They should not have sharp or jagged edges that could pose safety hazards.
- D. Material Type:
 - 1. Granite, limestone, or other durable, weather-resistant natural stones are preferred, unless specified otherwise.
 - 2. The material should be compatible with the surrounding landscape and resistant to weathering and erosion.
- E. Surface Texture
 - 1. The surface of the boulders should exhibit natural weathering and be rough or textured. Boulders should not have smooth or polished surfaces that may detract from the natural aesthetic.
- F. Color
 - 1. Boulders should have natural, earth-tone colors that blend with the surrounding environment. Common colors include gray, brown, tan, and rust shades, unless specified otherwise.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. The area where the boulders will be placed must be properly graded and compacted to provide a stable base.
- B. Excavate areas to a sufficient depth to accommodate the boulder size and ensure the boulder sits securely on the subgrade.
- C. The subgrade should be free of loose soil, debris, or organic matter that could compromise the stability of the boulder.

3.02 PLACEMENT OF BOULDERS

- A. Boulders shall be placed by mechanical equipment or hand tools, depending on the size and weight of the boulders.
- B. Bury $\frac{1}{3}$ of the boulder's height below the finished grade.

- C. Each boulder must be placed so that it is securely positioned and stable. If needed, use gravel or sand beneath the boulders for leveling and to prevent shifting.
- D. Boulders should be oriented in a way that maximizes their visual appeal, with the most aesthetically pleasing side facing outward.
- E. Ensure that the boulders are fully integrated into the surrounding landscape, with natural transitions from the boulder to the soil, turf, or surrounding elements.
- F. Ensure no boulders are placed in direct contact with irrigation systems, as this could cause damage or create uneven moisture distribution.
- G. Final Positioning
 - 1. The top of the boulders should be positioned level or slightly recessed to maintain a natural look, with no part of the boulder protruding too high above the surrounding grade unless intended for visual impact.
 - 2. When stacking boulders (if specified), the larger, heavier boulders should be placed at the bottom, with progressively smaller boulders placed above to create a stable stack.

3.03 MAINTENANCE

- A. Ongoing Stability
 - 1. After installation, periodically inspect the boulders to ensure they remain stable and securely positioned. Boulders that shift or become unstable due to shifting soil or water erosion should be reset.
- B. Weed Control
- C. If the boulders are placed in planting beds or areas that may be susceptible to weed growth, a weed barrier or geotextile fabric may be installed beneath the boulders to prevent unwanted vegetation from growing around them.

3.04 TOLERANCES

- A. Size Tolerance
 - 1. Boulders shall vary in diameter from 3 feet to 4 feet, with an allowable variance of +/- 6 inches in the final installed size.
- B. Positioning Tolerance
 - 1. Boulders should be placed within 2 inches of the specified locations shown in the design drawings, with appropriate adjustment for visual alignment.

**SECTION 321713
PARKING BUMPERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Precast concrete parking bumpers and anchorage.

1.02 REFERENCE STANDARDS

- A. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- B. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- C. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
- D. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete; 2017a.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide unit configuration, dimensions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Parking Bumpers: Precast concrete, complying with the following:
 - 1. Nominal Size: 6 inches high, 6 inches wide, 6 feet long.
 - 2. Profile: Manufacturer's standard.
 - 3. Cement: ASTM C150/C150M, Portland Type I - Normal; white color.
 - 4. Concrete Materials: ASTM C330/C330M aggregate, water, and sand.
 - 5. Reinforcing Steel: ASTM A615/A615M, deformed steel bars; unfinished, strength and size commensurate with precast unit design.
 - 6. Air Entrainment Admixture: ASTM C260/C260M.
 - 7. Concrete Mix: Minimum 5,000 psi compressive strength after 28 days, air entrained to 5 to 7 percent.
 - 8. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during manufacture.
 - 9. Embed reinforcing steel, and drill or sleeve for two dowels.
 - 10. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
 - 11. Minor patching in plant is acceptable, providing appearance of units is not impaired.
- B. Dowels: Cut reinforcing steel, 1/2 inch diameter, 18 inch long, pointed tip.
- C. Adhesive: Epoxy type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install units without damage to shape or finish. Replace or repair damaged units.
- B. Install units in alignment with adjacent work.
- C. Fasten units in place with 2 dowels per unit.

**SECTION 321723
PAVEMENT MARKINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Painted pavement markings.

1.02 RELATED REQUIREMENTS

- A. Section 321200-Asphalt Concrete Paving
- B. Section 321313 - Concrete Paving.
- C. Section 321713 - Parking Bumpers.
- D. Section 321726 - Tactile Warning Surfacing.
- E. CITY OF CHICO STANDARD FIRE LANE MARKING - <https://chico.ca.us/documents/City-Services/Fire-Department/CFD%20Forms%20for%20new%20website/Fire-Lane-Marking-0407.pdf>

1.03 REFERENCE STANDARDS

- A. AASHTO M 237 - Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete; 2005 (Reapproved 2019).
- B. AASHTO MP 24 - Standard Specification for Waterborne White and Yellow Traffic Paints; 2015 (Reapproved 2020).
- C. FHWA MUTCD - Manual on Uniform Traffic Control Devices; 2023.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
- C. Stencils Cut Sheets:
 - 1. ADA Symbol
 - 2. EV Symbol
 - 3. FIRE LANE NO PARKING
- D. Manufacturer's Instructions:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.

1.05 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 work of the type specified and with at least three years of documented experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
- B. Store products in manufacturer's unopened packaging until ready for installation.

1.07 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

1.08 SEQUENCING

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of markings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Painted Pavement Markings:
 - 1. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Flat Zone Marking Paint.
 - 2. PPG Traffic Solutions; Ennis Flint Fast Dry Waterborne Traffic Paint, 9852x Series.

2.02 PAINTED PAVEMENT MARKINGS

- A. Comply with State of California Highway Department standards.
- B. Painted Pavement Markings: As indicated on drawings.
 - 1. Marking Paint: In accordance with AASHTO MP 24.
 - a. Parking Lots: White.
 - b. Symbols and Text: White.
 - c. Wheelchair Symbols: Provide blue and white.
 - d. EV Symbols: green and white.
 - e. Fire Lane Curb:
 - 1) Color: Red.
 - 2) Stenciled letters should be a minimum of 4 inches in height with a 3/4-inch stroke width.
 - 3) Markings should be placed every 25 to 30 feet along the curb.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Verify that pavement is dry and ready for installation.
- B. Notify Landscape Architect of unsatisfactory conditions before proceeding.

3.02 PREPARATION

- A. Clean surfaces prior to installation.
 - 1. Remove dust, dirt, and other debris.
- B. Apply paint stencils by type and color at necessary intervals.

3.03 INSTALLATION

- A. General:
 - 1. Position pavement markings as indicated on drawings.
 - 2. Field location adjustments require approval of Landscape Architect.
- B. Painted Pavement Markings:
 - 1. Apply in accordance with manufacturer's instructions.
 - 2. Apply in accordance with State of California Highway Department standards.
 - 3. Apply in accordance with FHWA MUTCD standards.
 - 4. Marking Paint: Apply uniformly, with sharp edges.
 - a. Applications: One coat.
 - b. Wet Film Thickness: 0.015 inch, minimum.
 - c. Stencils: Lay flat against pavement, align with striping, remove after application.

3.04 TOLERANCES

- A. Maximum Variation From True Position: 3 inches (76 mm).
- B. Maximum Offset From True Alignment: 3 inches (76 mm).

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.

- B. Allow the pavement marking to set at least the minimum time recommended by manufacturer.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for additional requirements.
- B. Temporary Markings: Remove without damaging surfaces.

3.07 PROTECTION

- A. Prevent approaching traffic from crossing newly applied pavement markings.
- B. Replace damaged or removed markings at no additional cost to Owner.

**SECTION 321726
TACTILE WARNING SURFACING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tactile warning surfacing for pedestrian walking surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 321313 - Concrete Paving: Concrete sidewalks.
- B. Section 321723 - Pavement Markings: Crosswalk and curb markings.

1.03 REFERENCE STANDARDS

- A. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- B. ATBCB PROWAG - Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way; 2011.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Submit plan and detail drawings. Indicate:
 - 1. Locations on project site. Demonstrate compliance with referenced accessibility standards.
 - 2. Sizes and layout.
 - 3. Pattern spacing and orientation.
 - 4. Attachment and fastener details, if applicable
- C. Warranty: Submit manufacturer warranty; complete forms in Owner's name and register with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to project site in manufacturer's protective wrapping and in manufacturer's unopened packaging.
- B. Store covered and elevated above grade and in manufacturer's unopened packaging until ready for installation. Maintain at ambient temperature between 40 and 90 degrees F.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Cast Iron Tiles: Provide manufacturer's standard ten year warranty against manufacturing defects, breakage or deformation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cast Iron Detectable Warning Plates:
 - 1. Neenah Foundry, a division of Neenah Enterprises, Inc; _____: www.nfco.com/#sle.

2.02 TACTILE AND DETECTABLE WARNING DEVICES

- A. Cast Iron Detectable Warning Plates:
 - 1. Material: Cast gray iron; ASTM A48/A48M, Class 30 A (minimum).
 - 2. Installation Method: Cast in place.
 - 3. Shape: Rectangular and Radius.
 - 4. Color: Black or Charcoal.
 - 5. Products:
 - a. Neenah Foundry, a division of Neenah Enterprises, Inc; _____: www.nfco.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. When installation location is near site boundary or property line, verify required location using property survey.
- B. Verify that work area is ready to receive work:
 - 1. If existing conditions are not as required to properly complete the work of this section, notify Landscape Architect.
 - 2. Do not proceed with installation until deficiencies in existing conditions have been corrected.
- C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.02 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's written instructions.
 - 1. Do not install damaged, warped, bowed, dented, abraded, or otherwise defective units.
 - 2. Do not install when ambient or substrate temperature has been below 40 degrees F during the preceding 8 daylight hours.
- B. Field Adjustment:
 - 1. Locate relative to curb line in compliance with ATBCB PROWAG, Sections 304 and 305.
 - 2. Orient so dome pattern is aligned with the direction of ramp.
- C. Install units fully seated to substrate, square to straight edges and flat to required slope.

3.03 INSTALLATION - CAST IN PLACE, CAST IRON PLATES

- A. Install by method described in manufacturer's written instructions.
- B. Place units into wet concrete.
- C. Press assembly into concrete to achieve final elevation.
- D. Finish concrete adjacent to plate. Remove wet concrete spilled onto plate surface.

3.04 PROTECTION

- A. Protect installed units from traffic, subsequent construction operations or other imposed loads until concrete is fully cured.
- B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

**SECTION 321813
SYNTHETIC GRASS SURFACING**

PART 1 - WORK

1.01 SCOPE

- 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 310000 – Earthwork

1.03 REFERENCES

- A. ATSM Standard Test Methods
 1. D1577 – Standard Test Method for Linear Density of Textile Fiber
 2. D5848 – Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Covering
 3. D418 – Standard Test Method for Testing Pile Yarn Floor Covering Construction
 4. D1338 – Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings
 5. D1682 – Standard Method of Test for Breaking Load and Elongation of Textile Fabrics
 6. D5034 – Standard Test Method of Breaking Strength and Elongation of Textile Fabrics (Grab Test)
 7. F1551 – Standard Test Methods for Water Permeability
 8. D2859 – Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
 9. F355 – Standard Test Method for Shock-Absorbing Properties of Playing Surfaces
 10. 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 1/4" 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™ Elite" synthetic turf system as provided by STI™. (800) 405-7455, 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 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
 - 1. changed after the contract is awarded unless approved by the Owner in writing.
- B. 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.

- C. 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.
- D. Submit a 1-lb sample of the selected bid infill material(s).
- E. A letter and specification sheet certifying that the products of this section meet or exceed specified requirements.
- F. Certified copies of independent (third-party) laboratory reports on ASTM tests as follows:
 - 1. Pile Height, Face Width & Total Fabric Weight, ASTM D418 or D5848
 - 2. Primary & Secondary Backing Weights, ASTM D418 or D5848
 - 3. Tuft Bind, ASTM D1335
 - 4. Grab Tear Strength, ASTM D1682 or D5034
- G. 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.
- H. 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.
- I. 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 56 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)	10400 (6000 nylo n/4400 nylo m)	ASTM D 1577
Yarn Thickness	100 Microns	ASTM D 3218
Tensile Strength	16 N	ASTM D 2256
Pile Weight*	56 oz./sq.yd.	ASTM D 5848

1) Notes:

- (a) Fiber manufacturer must be from the same source.
- (b) The above specifications are nominal.
- (c) *Values are $\pm 5\%$.

9. The pile fabric shall possess the following physical characteristics:

Characteristic	Value	Test
Finished Pile Height*	1 1/4"	ASTM D5823
Product Weight (total)*	83 oz./sq.yd	ASTM D 3218
Primary Backing Weight*	7.4 oz./sq.yd	ASTM D 2256
Secondary Coating Weight**	20 oz./sq.yd	ASTM D 5848
Fabric Width	15' (4.57m)	ASTM D 5793
Tuft Gauge	1/4"	ASTM D 5793
Grab Tear Strength	200+ lb·f	ASTM D5034
Tuft Bind	???10 lb·f	ASTM D1335
Infill (Sand)	2 lbs Silica Sand	None
Infill (Rubber)	N/A	None

1) Notes:

- (a) Except where noted as a minimum, the above specifications are nominal.
- (b) *Values are $\pm 5\%$.
- (c) **All values are ± 3 oz./sq.yd.

1.02 BACKING MATERIAL

A. Primary Backing:

1. Primary backing must be a dual layered woven polypropylene material, ArmorLoc™ 3L.
2. Primary backing system weight must be a minimum of 7.0 ounces/square yard.

B. Secondary Backing:

1. Secondary backing system weight must be a minimum of 20 ounces/ square yard.
2. Secondary backing SilverBack™ shall saturate the primary backing and effectively lock the fiber tufts in place to the primary backing.
3. Secondary backing must be a heat activated polyurethane coating with no vegetable based polyols.
4. Secondary backing system shall have minimum tuft bind strength of 10 pounds.

5. Secondary backing must have Drainage Perforations: 3/16" to 1/4" 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 D2859.

1.03 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.

1.04 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:
 - 1) Color – tan
 - 2) Sand shall be round non-angular in shape
 - 3) Roundness – 0.6+
 - 4) Hardness - 0.6-0.8 on the Mohs Scale
 - 5) Size – 0.04 inch ± 0.01 inch
 - 6) Density – 90 – 95 lbs/ cu ft.
 - 7) Dust - ??? 0.001 %
 - 8) Angle of Repose - ??? 30°
 - 9) 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 inch this document and shall be of the following Mesh Size Distribution:
 - 1) % Retained
 - 2) 0-15%
 - 3) 5-30%
 - 4) 40-70%
 - 5) 15-35%
 - 6) 0-10%
 - 7) 0-1%
 - 8) 0-1%

PART 3 EXECUTION

2.01 GENERAL

- A. REFERENCE STANDARDS

- B. ASTM D1335 - Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings; 2021.
- C. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).
- D. ASTM D5034 - Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test); 2021.
- E. ASTM D5823 - Standard Test Method for Tuft Height of Pile Floor Coverings; 2019.
- F. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).
- G. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015.
- H. Installation of the synthetic turf system is to comply with the manufacturer's recommendations, requirements and the reviewed and approved shop drawings.
- I. 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.
- J. 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.
- K. All products and equipment are to be from sources approved by the authorized turf manufacturer and conform to the specifications.

2.02 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.

2.03 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.

2.04 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.

2.05 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.

**SECTION 323113
CHAIN LINK FENCES AND GATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Posts, rails, and frames.
- B. Wire fabric.
- C. Concrete.
- D. Manual gates with related hardware.
- E. Accessories.

1.02 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a (Reapproved 2022).
- D. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.
- E. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2023.
- F. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework; 2018 (Reapproved 2022).
- G. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2018 (Reapproved 2022).
- H. CLFMI CLF-FIG0111 - Field Inspection Guide; 2014.
- I. CLFMI CLF-SFR0111 - Security Fencing Recommendations; 2014.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.
- D. Samples: Submit two samples of fence fabric, Polypropylene Solid Weave , 6 inch by 6 inch in size illustrating construction and colored finish.

1.04 QUALITY ASSURANCE

- A. Fence Installer: Company with demonstrated successful experience installing similar projects and products, with not less than five years of documented experience.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Chain Link Fences and Gates:
 - 1. Master-Halco, Inc; _____: www.masterhalco.com/#sle.
 - 2. Merchants Metals; _____: www.merchantsmetals.com
 - 3. Ameristar; www.ameristarperimeter.com.

4. Substitutions: See Section 016000 - Product Requirements.
- B. Screening Fabric:
 1. Douglas Industries, Inc; www.douglas-sports.com
 2. Cover Sports; www.coversports.com
 3. Substitutions: See Section 016000-Product Requirements.

2.02 COMPONENTS

- A. Line Posts: 1.9 inch diameter.
- B. Corner and Terminal Posts: 2.38 inch diameter.
- C. Gate Posts: 3-1/2 inch diameter.
- D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
- E. Bottom Rail: 1.66 inch diameter, plain end, sleeve coupled.
- F. Gate Frame: 1.66 inch diameter for welded fabrication.
- G. Fabric: 2 inch diamond mesh interwoven wire, 6 gauge, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.
- H. Fabric with Pre-Inserted Slats: 2 inch diamond mesh interwoven wire, 6 gauge, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.
 1. Privacy Slats: High-density polyethylene (HDPE), woven into fabric.
 - a. Visual Barrier: 95 percent.
 - b. Slat Color: Black.
- I. Tension Wire: 6 gauge, 0.1920 inch thick steel, single strand.
- J. Tie Wire: Aluminum alloy steel wire.

2.03 MATERIALS

- A. Posts, Rails, and Frames:
 1. ASTM A1011/A1011M, Designation SS; hot-rolled steel strip, cold formed to pipe configuration, longitudinally welded construction, minimum yield strength of 50 ksi; zinc coating complying with ASTM F1043 and ASTM F1083.
 2. Line Posts: Type I round in accordance with FS RR-F-191/1D.
 3. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.
- B. Wire Fabric:
 1. ASTM A392 zinc coated steel chain link fabric.
- C. Concrete:
 1. Ready-mixed, complying with ASTM C94/C94M; normal Portland cement; 3000 psi strength at 28 days, 3 inch slump; 3/4 inch nominal size aggregate.

2.04 COMPONENTS

- A. Line Posts: 1.9 inch diameter.
- B. Corner and Terminal Posts: 2.38 inch diameter.

2.05 MANUAL GATES AND RELATED HARDWARE

- A. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; .
- B. Hardware for Double Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position.
- C. Hinges: Finished to match fence components.
 1. Brackets: Square.

2. Mounting: Center.
 3. Closing: Self.
 4. Products:
 - a. D&D Technologies USA, Inc; SHUT IT, Model _____: www.ddtech.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- D. Latches: Finished to match fence components.
1. Brackets: Square.
 2. Locking: Mechanical.
 3. Products:
 - a. D&D Technologies USA, Inc; LokkLatch, Model _____: www.ddtech.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.06 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

2.07 FINISHES

- A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 ounces per square foot.
- B. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Verify that areas are clear of obstructions or debris and proper grades..

3.02 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
- B. Place fabric on outside of posts and rails.
- C. Set intermediate posts plumb , in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- D. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install brace rail one bay from end and gate posts.
- E. Provide top rail through line post tops and splice with 6 inch long rail sleeves.
- F. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
- G. Position bottom of fabric 2 inches above finished grade.
- H. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- I. Do not attach fence to building wall; provide posts.
- J. Peen all bolts upon installation.

3.03 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
- C. Gates: Inspect for level, plumb, and alignment.

- D. Workmanship: Verify neat installation free of defects. See CLFMI CLF-FIG0111 for field inspection guidance.

3.05 CLEANING

- A. Leave immediate work area neat at end of each work day.
- B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- C. Clean fence with mild household detergent and clean water rinse well.
- D. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.

3.06 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.

**SECTION 323119
DECORATIVE METAL FENCES AND GATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Decorative aluminum fences.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- E. ASTM D523 - Standard Test Method for Specular Gloss; 2014 (Reapproved 2018).
- F. ASTM D714 - Standard Test Method for Evaluating Degree of Blistering of Paints; 2002 (Reapproved 2017).
- G. ASTM D822/D822M - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings; 2013 (Reapproved 2018).
- H. ASTM D1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments; 2008, with Editorial Revision (2017).
- I. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates; 2023.
- J. ASTM D2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact); 1993 (Reapproved 2024).
- K. ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test; 2023.
- L. ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets; 2016 (Reapproved 2023).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to start of work of this section; require attendance by affected installers.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Shop Drawings:
 - 1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
- C. Manufacturer's Qualification Statement.
- D. Installer's Qualification Statement.
- E. Manufacturer's Warranty.

1.06 QUALITY ASSURANCE

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

- B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

- A. Correct defective Work within a five year period after Date of Substantial Completion.
- B. Provide five year manufacturer warranty for coating and defects in workmanship or materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Decorative Metal Fences and Gates:
 - 1. Ameristar Perimeter Security, USA: www.ameristarfence.com/#sle.
 - 2. Substitutions: or approved equal.

2.02 FENCES

- A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
 - 1. Capable of resisting vertical load, horizontal load and infill performance requirements for fence categories defined in ASTM F2408.
- B. Electro-Deposition Coating: Multistage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
 - 1. Total Coating Thickness: 2 mils, minimum.
 - 2. Color: BLACK.
 - 3. Coating Performance: Comply with general requirements of ASTM F2408.
 - a. Adhesion: ASTM D3359 (Method B); Class 3B with 90 percent or more of coating remaining in tested area.
 - b. Corrosion Resistance: ASTM B117, ASTM D714 and ASTM D1654; 1/8 inch coating loss or medium No.8 blisters after 1,500 hours.
 - c. Impact Resistance: ASTM D2794; 60 inch pounds.
 - d. Weathering Resistance: ASTM D523, ASTM D822/D822M and ASTM D2244; less than 60 percent loss of gloss.
- C. Steel: ASTM A653/A653M; tensile strength 45,000 psi, minimum.
 - 1. Hot-dip galvanized; ASTM A653/A653M, G60.
 - 2. 62 percent recycled steel, minimum.
- D. Aluminum: ASTM B221.
 - 1. Tubular Pickets, Rails and Posts: 6005-T5 alloy.
 - 2. Extrusions for Posts and Rails (Outer Channel): 6005-T5 alloy.
 - 3. Extrusions for Pickets and Rail (Inner Slide Channels): 6063-T5 alloy.
- E. Fasteners: ASTM A276/A276M, Type 302 stainless steel; finished to match fence components.
 - 1. Self-drilling hex-head screws.
- F. Hinges: Finished to match fence components.
 - 1. Brackets: Round.
 - 2. Mounting: Center.
 - 3. Closing: Self.
- G. Latches: Finished to match fence components.
 - 1. Brackets: Round.
 - 2. Locking: Mechanical.

2.03 ALUMINUM FENCE

- A. Decorative Aluminum Fence System: Provide fence meeting the Test Load and Coating Performance requirements of ASTM F2408 for Industrial class.
 - 1. Fence Panels: 4 feet high by 6 feet long.
 - a. Panel Style: Three rail.
 - b. Posts: Aluminum extrusions; 2-1/2 inches square.
 - c. Rails: Extruded aluminum channels.
 - d. Pickets: Extruded aluminum tubes.
 - 1) Style: Pickets with finial extend above top rail.
 - e. Fasteners: Manufacturer's standard stainless steel bolts, screws, and washers; factory finish fasteners to match fence.
 - f. Accessories: Aluminum castings, extrusions, and cold-formed strips; factory finished to match fence.
 - 1) Flat post cap.
 - g. Color: Manufacturer's standard, factory applied Black.
- B. Decorative Aluminum Privacy Fence and Swinging Gates:
 - 1. Fence Panels: Formed aluminum sheets; 6 feet high by 6 feet long.
 - a. Panel Style: Board-on-board.
 - b. Attach panels to posts with manufacturer's standard panel brackets and recommended fasteners.
 - 2. Posts: Aluminum extrusions; 4 inches square.
 - 3. Color: Manufacturer's standard, factory applied Black.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Set fence posts in accordance with the manufacturer recommended spacing.
- C. When cutting rails immediately seal the exposed surfaces by:
 - 1. Removing metal shavings from cut area.
 - 2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
 - 3. Apply two coats of custom finish spray paint matching fence color.
 - 4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.
- D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
 - 1. Base type and quantity of gate hinges on the application, weight, height, and number of gate cycles.
 - 2. Identify the necessary hardware required for the application on the manufacturer's gate drawings.
 - 3. Provide gate hardware by the manufacturer of the gate and install in compliance with manufacturer's recommendations.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From Indicated Position: 1 inch.

- C. Minimum Distance from Property Line: 6 inches.

3.05 FIELD QUALITY CONTROL

- A. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
- B. Gates: Inspect for level, plumb, and alignment.
- C. Workmanship: Verify neat installation free of defects.

3.06 CLEANING

- A. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- B. Clean fence with mild household detergent and clean water rinse well.
- C. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.
- D. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.07 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.

3.08 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

**SECTION 323300
SITE FURNISHINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Benches.
- B. Bollards.
- C. Bike Racks.
- D. Tables/Chairs.
- E. Waste receptacles.
- F. Recycling receptacles.
- G. Shade Structures.
- H. Bleachers.
- I. Cabanas.
- J. Outdoor Shower.

1.02 REFERENCE STANDARDS

- A. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's specifications and descriptive literature, installation instructions, and maintenance information.
- C. Shop Drawings: Indicate plans for each unit or group of units, elevations with model number, overall dimensions, construction, and anchorage details.
- D. Samples: Submit two sets of manufacturer's available colors for metal furnishings.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide manufacturer's warranty against defects in materials or workmanship for a period of 10 years from Date of Substantial Completion, or approved maximum manufacturer's warranty timeline.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnishings:
 - 1. See Site Furniture; Schedule B on drawing sheet LS100..
 - 2. Substitutions: See Section 012500 - Substitution Procedures.

2.02 BOLLARDS

- A. Steel Pipe Bollards: Hollow steel pipe with plain shaft.
 - 1. Materials:
 - a. Steel Pipe: ASTM A53/A53M, standard weight.
 - b. Factory Finish: Primed.
 - c. Top Coat Painted: Black.
 - d. Mounting: Embedded.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install site furnishings in accordance with approved shop drawings, and manufacturer's installation instructions.

**SECTION 323313
PRECAST CONCRETE SITE FURNISHINGS**

PART 1

1.01 SUMMARY

- A. Perform all work required to furnish and complete the proper installation of precast concrete.

1.02 TYPES OF PRECAST CONCRETE WORK INCLUDE:

- A. Precast Concrete Benches
- B. Setting material, grouts, sealants and caulks
- C. Installation of precast concrete
- D. Related work not specified under this section
 - 1. Installation of steel units to receive precast concrete
 - 2. Installation of Concrete substrate to receive precast

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C-150
 - 2. ASTM C-128
 - 3. ASTM C-260
 - 4. ASTM C-31
 - 5. ASTM C-494
 - 6. ASTM C-39
 - 7. Precast Concrete Institute (PCI)

1.04 SUBMITTALS

- A. Shop Drawings
 - 1. Submit fabrication drawings of all precast concrete items showing detailed sections and profile for all precast items. Details shall show all reinforcing and cast in hardware.
- B. Samples
 - 1. Submit 1 sample for color and texture approval.
 - a. Color to be selected from manufacturer's standard offerings.
 - b. Match existing or architect's sample
 - c. Custom Sample Number
- C. Submit a copy of manufacturer's Quality Assurance and Procedure Manual
- D. Performance Requirements
 - 1. Compressive Strength 5,000 p.s.i. minimum
 - 2. Air Content 6-8%
 - 3. Water-Cement Ratio .45
 - 4. Deflection Max: L/720
- E. Test Results
 - 1. Manufacturer shall furnish test results attesting that materials meet specification requirements.

1.05 QUALITY ASSURANCE

- A. Qualifications: Precast Concrete Manufacturer and Trade Contractor must have a minimum of 5 years of successful experience on projects of similar magnitude and complexity to the indicated project.
- B. Manufacturer and contractor to be prequalified by Architect prior to bidding and failure to do so will void bid.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packaging and Shipping: precast concrete to be palletized, shrink wrapped and marked with legible manufacturer identification, including piece number and quantities.
- B. Storage and Protection precast concrete to be stored in secure area in original packaging.
- C. Protect from damage by other trades.
- D. Report all damage due to shipment immediately. Customer is required to sign the Bill of Lading slip detailing the damaged product. Picture proof is required.

1.07 WARRANTY

- A. For a period of two (2) years from delivery of precast concrete, manufacturer warrants the precast concrete products against defects in workmanship and materials per industry standards. This warranty does not cover the above products for cracking and faulting caused by settling due to improper or faulty substrates or improper installation; nor does it cover damage caused by impact, vandalism or natural disaster.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer:
 - 1. Wausau Tile, Inc. | 1.800.388.8728 | info@wausautile.com | www.wausautile.com
- B. Clarification Note: Drawings and specifications are based on manufacturer's proprietary literature from Wausau Tile, Inc. Other manufacturers shall comply with minimum levels of material specifications and detailing indicated on the drawings of specified herein.

2.02 MATERIAL REQUIREMENTS

- A. Portland Cement: ASTM C-150 Specifications for Portland Cement.
- B. Aggregates: Aggregate shall be blended to meet individual project requirements.
- C. Coloring; Pigments used shall be inorganic, resistant to alkalinity and used per manufacturer's recommendations.
- D. Reinforcement and Hardware:
 - 1. Reinforce precast with deformed rods as recommended by precast concrete manufacturer.
- E. Abrasive Inserts: Shall consist of silica sand and epoxy.
 - 1. Abrasive Color:
 - 2. Specify one to three lines.
- F. Setting Materials, Caulks & Sealants
 - 1. Color(s) to be selected by Architect.
 - 2. Sealer: Colorless, pure acrylic water repellent sealer. Sealer to maintain natural look of concrete surface with no glaze or gloss, darkening or color change.
 - 3. Precast manufacturer is not a reseller for any of the above products. Please contact the following supplier for information and recommendations on job specific installation materials:
 - a. Acceptable Supplier:
 - 1) Custom Building Products/Aqua Mix, 800-272-878
 - 2) E-mail: info@cbpmail.net Website: www.custombuildingproducts.com

2.03 MANUFACTURED UNITS

- A. Sizing Tolerances
 - 1. All units to conform to shop drawings with a (+/-) 1/8" tolerance in dimension.
- B. Precast Surfaces and Edges:
 - 1. All exposed edges to have minimum of 1/8" radius to prevent chipping.
 - 2. All finished surfaces to match approved control sample.
 - 3. All precast concrete finished surfaces to be factory sealed.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine substrates for the following:
 - 1. Defects or cracks in existing work or substrate.
 - 2. Deviations beyond allowable tolerances for the substrate.
- B. Continue with installation of precast units only when all defects have been corrected.

3.02 PROJECT CONDITIONS

- A. Do not install products under environmental conditions outside setting material manufacturer's absolute limits.

3.03 INSTALLATION

- A. Precast Tread setting methods include
 - 1. Thin Set Application
 - a. Substrate of concrete or steel (steel at interior application only). Must be within a tolerance of 1/8" in all dimensions.
 - b. Latex modified thin set mortar used over concrete substrate.
 - 1) Setting bed must be continuous under the entire length of the tread and behind the entire riser. Setting materials utilized per manufacture's recommended instruction.
 - c. Epoxy thin set is used over steel substrate.
 - 1) Setting bed must be continuous under the entire length of the tread and behind the entire riser. Setting materials utilized per manufacture's recommended instruction.
 - d. Set treads level and plumb to meet finished nosing layout.
 - 2. Mortar Set Application
 - a. Substrate of concrete or steel (steel at interior application only). Must be within a tolerance of 1/8" in all dimensions.
 - b. The height of the mortar bed is established based on tread nosing layout marks and precast thickness. The mortar bed is then placed or screeded over primed substrate.
 - 1) Setting bed must be continuous under the entire length of the tread and behind the entire riser. Setting materials utilized per manufacture's recommended instruction.
 - c. Set treads level and plumb to meet finished nosing layout.
 - 3. Tab Set Application
 - a. Substrate of concrete or steel (steel at interior application only) must be within a tolerance of 1/8" in all dimensions.
 - b. Tabs to be set at front and back of tread every 12" O.C. minimum.
 - c. Set treads level and plumb to established nosing layout.
- B. Joints
 - 1. Joints between adjacent precast should be a minimum of 1/8"-1/4".
- C. Caulking of Precast
 - 1. Clean all joints thoroughly, removing all debris.
 - 2. Wipe all joints with caulk manufacturer's recommended cleaner prior to application.
 - 3. Use urethane caulk. (Color match caulk to precast per architect selection.)
 - 4. Clean up after caulking as per caulk manufacturer's recommendations.
- D. Precast Concrete products setting or installation methods are to be reviewed by the manufacturer and setting materials supplier.
- E. Final Cleaning of Precast Concrete
 - 1. Check all surfaces and caulking, make repairs as necessary.
 - 2. Clean treads with a pH balanced soap.

- F. Protection:
 - 1. Upon completion, the work shall be ready for final inspection and acceptance by owner or owner's agent.
 - 2. General Contractor shall protect the finished work from the time the installing contractor completes the work.
- G. Finish:
 - 1. Overall match to approved sample and per industry standards.
 - 2. All products to be factory sealed.

PART 4 – CARE AND MAINTENANCE

4.01 CLEANING

- A. To preserve the appearance and extend the life of the Precast Concrete cleaning and maintenance processes must be in place. When using the following procedures, please follow the product manufacturer's instructions regarding the use of any equipment or cleaning materials described here.
 - 1. Power sweep, then pressure wash precast surface. Spot clean any stained areas.
 - 2. Spot clean any stained areas by using a neutral, non-aggressive cleaner. This may require effort to remove some of the tougher marks or stains.
 - a. Example of off-the-shelf cleaners: Citrus cleaner, Simple Green
 - 3. Always start with the most neutral cleaner and work your way toward the more aggressive cleaners.
 - 4. In extreme cases, contact Wausau Tile to discuss options
 - 5. Be sure to use plastic, rubber or nylon tip equipment; this will help prevent scratches on the concrete.
- B. Precast Concrete is built to withstand aggressive cleaning; however, the more aggressive the cleaner, the more risk is involved. Strict adherence to all product warnings is suggested.
- C. In all cases after cleaning and/or patching, it is recommended that the Precast be sealed. This will help protect the product from environmental effects. Contact manufacturer to obtain sealer and stain information based on specific job.

4.02 MAINTENANCE

- A. Annual maintenance is recommended; however, in cases of extreme use, the best time for application is when the appearance of the product is showing wear or is appearing dull.
- B. Check the precast for broken and chipped pieces. If damaged, contact manufacturer before repairing to order a patch kit and obtain patching procedures.
- C. De-icing salts can damage concrete, causing them to scale or break apart. If necessary, these chemicals should be used sparingly and with caution on our concrete products.
 - 1. Salt based products are not recommended
- D. De-icers should be used only when necessary to help loosen snow and ice, and make removal easier. Never over-apply de-icing products. Mix the de-icers with sand to increase their effectiveness and reduce overall use.
 - 1. Always read and follow label directions when applying de-icing materials.
 - 2. Calcium magnesium acetate chloride tends to cause the least amount of damage to Precast Concrete
- E. Other manufacturer's products used in conjunction with the Precast Concrete may require additional maintenance. Including but not limited to: Wood, Metals, Plastics, etc. Contact product specific manufacturers for their maintenance requirements.

**SECTION 328423
PLANTING IRRIGATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Irrigation system with design delegated to the Contractor.
- B. Pipe and fittings, valves, emitters, and accessories.
- C. Control system.

1.02 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B1.20.7 - Hose Coupling Screw Threads (Inch); 1991 (Reaffirmed 2024).
- C. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- D. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2020.
- E. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2023.
- F. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2023.
- G. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.
- H. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe; 2021.
- I. ASTM D2672 - Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement; 2020.
- J. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.
- K. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2018.
- L. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings; 2021.
- M. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 DEFINITIONS

- A. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
- B. Lateral Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with site backfilling, landscape grading and delivery of plant life.
- B. Preinstallation Meeting: Convene one week prior to commencing work of this Section.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: The Contractor shall submit catalog information of all equipment for approval.
- C. Qualification Data for Designer: Include list of similar projects completed demonstrating Designer's capabilities and experience. List Designer's professional registcertifications. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- D. Qualification Data for 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.
- E. Delegated Design Drawings: Comply with the performance requirements and design criteria, including analysis data.
 - 1. Indicate piping layout from water source, location of sleeves under pavement, location and coverage of sprinkler heads, zone valves, pipe layout and sizes, schedule of irrigation equipment and typical irrigation installation details.
- F. Certificate: Certify that products of this section approved by authority having jurisdiction.
- G. Operation and Maintenance Manual:
 - 1. Complete and submit the following information to the Landscape Architect prior to substantial completion in PDF format:
 - a. Cover sheet stating Contractor's address and mobile telephone number, list of equipment with name and addresses of local supplier.
 - b. Catalog and parts sheets on all material and equipment installed.
 - c. Statement of Warranty: Describing an understanding of the required warranty. Provide name and phone number for responsible contact. Include manufacturer's product warranty for each component installed.
 - d. Instructions for operation and maintenance of system and controls.
 - e. Winterization and spring start up procedures.
 - f. Schedule indicating length of time each valve is required to be open to provide a determined amount of water.
 - g. Inspection forms and test results, as applicable.
- H. Record Documents: The Contractor is responsible for documenting changes to the design.
 - 1. Record work that is installed differently than shown on the drawings. Record pipe and wiring network alterations and location changes to equipment. Keep documents current. Do not permanently cover work until as-built information is recorded.
 - 2. Turn over the Record Drawings to the Landscape Architect. Completion of the Record Drawings will be a prerequisite for irrigation system substantial completion and final payment.
 - 3. Controller Chart
 - a. Provide a controller chart for each controller, clearly showing show the zones controlled.
 - b. Use a different color to indicate the area of coverage for each zone.
 - c. Complete and submit to the Landscape Architect prior to Substantial Completion review of the irrigation system.
 - d. Upon approval the chart shall be laminated and attached to the inside of the controller enclosure, or mounted to a wall immediately adjacent to the controller.
- I. Maintenance Materials: Provide the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Two (2) keys for each automatic controller.
 - 3. Two (2) quick coupler keys and matching hose swivels for each type of quick coupling valve installed.

4. Two (2) sets of tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: design irrigation system, including comprehensive analysis, by a Irrigation Association Certified Irrigation Designer with not less than three years of documented experience, using performance requirements and design criteria indicated.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- C. Installer Qualifications: Contractor shall be a registered individual or firm in the state in which the work is performed. All work shall be performed under supervision of qualified personnel.
 1. Experience: An installer that has successfully installed projects of similar scope and size with minimum three years of experience.
 2. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- D. Mock-Up Installation of each irrigation detail demonstrating Contractor's understanding of the project requirements. Provide for approval a minimum of two (2) weeks prior to beginning permanent irrigation system installation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point.
- B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.
- C. Any section of pipe that has been dented or damaged will be discarded, or if installed, it shall be replaced with new piping.

1.08 WARRANTY

- A. The purpose of this guarantee/warranty is to ensure that the Owner receives irrigation materials of prime quality, installed and maintained in a thorough and careful manner.
- B. For a period of one year from date of Project Substantial Completion, the Contractor will guarantee/warranty irrigation materials, equipment, and workmanship against defects. Fill and repair depressions. Restore landscape or structural features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by a defective item. Make repair within seven days of notification from the Owner's Representative.
 1. Contract documents govern replacements identically as with new work. Make replacements at no additional cost to the contract price.
 2. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.
- C. Provide winterization and spring start up services at no additional charge during the warranty period.

PART 2 PRODUCTS

2.01 DELEGATED DESIGN REQUIREMENTS

- A. Design, furnish and install a complete automatic irrigation system for plant bed areas and a manual irrigation system with quick coupling valves for synthetic turf areas.

2.02 PERFORMANCE REQUIREMENTS

- A. Location of Irrigation and Specialties: Make minor adjustments necessary to avoid plantings and obstructions such as trees, signs and light poles.
 1. Minimum Working Pressures: Contractor shall verify the available flow and water pressure is adequate for the proposed irrigation and notify the Landscape Architect of any discrepancies. Verify if a booster pump is required.
 2. Unless noted otherwise, the construction of the irrigation system shall include the furnishing, installing, and testing of all mains, laterals, risers and fittings, gate valves,

control valves, controllers, electric wire, controls, and other necessary specialties and the removal and/or restoration of existing improvements, excavating and backfill, and all other work in accordance with the plans and specifications a required for a complete system.

- B. Do not willfully install irrigation when it is obvious in the field that unknown obstructions, grade differences, or discrepancies in area dimensions exist that might not have been considered in design. Such obstructions or differences shall immediately be brought to the attention of the Landscape Architect. In the event this notification is not performed, the Contractor assumes full responsibility for all necessary revision.
- C. Audit the completed irrigation system to be performed by an Irrigation Association Certified Irrigation Auditor:
 - 1. Analyze water requirements and irrigation use.
 - 2. Develop irrigation schedules based on water requirements, quality and availability.
 - 3. Make maintenance recommendations to keep the irrigation system working reliably and cost effectively.

2.03 IRRIGATION SYSTEM

- A. Regulatory Requirements:
 - 1. Comply with all local code requirements including, but not limited to, Model Water Efficient Landscape Ordinance (MWELO) and/or General Water Efficient Design Method.
 - 2. Comply with applicable code for piping and component requirements.
 - 3. Provide certificate of compliance from authority having jurisdiction indicating approval of products in system.
- B. Products: Use only new materials of brands and types noted on Drawings and specified herein, or approved equals. No substitutions will be allowed without prior written approval from the Landscape Architect. Equipment or materials installed or furnished without prior approval will be rejected and removed at the Contractor's expense.
- C. Manufacturers:
 - 1. Rain Bird Sales, Inc: www.rainbird.com/#sle.
 - 2. Hunter Industries: www.hunterindustries.com.
 - 3. Substitutions: See Section 016000 - Product Requirements.

2.04 PIPE MATERIALS

- A. All PVC pipe used on the site shall be from the same manufacturer. All pipe and fittings shall bear the manufacturer's name or trademark, material designation, size, schedule or class, and NSF seal of approval.
- B. PVC Pipe: ASTM D2241; 200 psi pressure rated; solvent weld joints for PVC pipe 3" and smaller and gasketed joints for pipe 4" and larger.
- C. PVC Pipe: ASTM D1785; Schedule 40; solvent welded sockets.
- D. PVC Fittings:
 - 1. PVC Socket Fittings: ASTM D2466, Schedule 40.
 - 2. PVC Threaded Fittings: ASTM D2464, Schedule 80.
 - a. All threaded connections shall be sealed using Teflon tape or paste.
- E. Pipe Risers at Valves: Schedule 80 PVC nipples.
- F. Solvent Cement: ASTM D2564 for PVC pipe and fittings. Include primer according to ASTM F656. Solvent to be appropriate for pipe and fitting type and weather conditions.
- G. Sleeves: Sleeves for pipes passing beneath paving shall conform to ASTM D2241, Schedule 40. Minimum diameter of 2 inch or 2 sizes larger than pipe scheduled to pass through them.
- H. PE Pipe with Controlled ID: ASTM D2239, PE4710 compound; SIDR 15.
 - 1. Sizes: 1-inch and 1-1/4-inch.
 - 2. Insert Fittings for PE Pipe: ASTM D2609, nylon or propylene plastic with barbed ends. Include stainless steel bands or other fasteners.

2.05 DRIP IRRIGATION

- A. Landscape Dripline:
 - 1. Flexible, linear low-density polyethylene, ultraviolet (UV) resistance.
 - 2. Pressure compensating emitters factory molded into tubing at set intervals to deliver water at 10-60 PSI
 - 3. Fittings: UV-resistant, glass reinforced polypropylene barbed fittings compatible with dripline tubing.
 - 4. Emitter spacing: as determined through delegated design to meet plant water needs.
 - 5. Emitter flow: as determined through delegated design to meet plant water needs.
 - 6. Line spacing: as determined through delegated design to meet plant water needs.
- B. Drip Control Zone Kit: factory-assembled automatic control valve with stainless steel filter and pressure regulator.
 - 1. Molded-plastic body, normally closed, diaphragm type with manual flow adjustment, adjustable pressure regulation, and operated by electric solenoid.
 - 2. Capable of operating between 20 to 120 PSI with consistent pressure regulation to 25 or 40 PSI.
 - 3. 150 mesh stainless steel filter, removable cap for service and cleaning.
 - 4. Include PVC isolation valve immediately upstream of each drip control zone kit.
- C. Flush Cap: manufacturer's standard barbed fitting with manually removable threaded cap located at the end of each run to assist with drip zone winterization.
- D. Operation Indicator: 6-inch pop up indicator with 1/2-inch bottom inlet activated when system pressure exceeds 12 PSI.
- E. Air Relief Valve: constructed of UV-protected and corrosion-resistant material with an operating range up to 80 PSI.

2.06 VALVES AND VALVE BOXES

- A. Gate Valves: Bronze construction non-rising stem.
- B. Automatic Control Valves: Molded-plastic body, normally closed, diaphragm type with manual flow adjustment, adjustable pressure regulation, and operated by elect.
- C. Quick Coupler: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7; 3/4-inch hose outlet.
 - 1. Locking-Top Option: Vandal-resistant locking feature.
 - 2. Delegated design Placement and Quantity: include a minimum of two (2) quick couplers in the irrigation plan. Coordinate location(s) with Owner.
- D. Water Meter: See civil drawings.
- E. Backflow Preventers: See civil drawings.
- F. Valve Box and Cover: with open bottom and openings for piping; designed for installing flush with grade.
 - 1. Size: As required for valves and service but no smaller than the following:
 - a. 15"x21"x12" deep for control valves.
 - b. 10" diameter for quick coupling or isolation valves.
 - c. 6" diameter for drip irrigation flush valves.
 - 2. Shape: Rectangular for control valves, circular for specialties as indicated on details.
 - 3. Material: PE or ABS. Use traffic rated polymer concrete valve boxes for application when installed in concrete pavement.
 - 4. Drainage Backfill: Clean gravel or crushed stone, graded from 3/8 inch minimum to 3/4 inches maximum, to 6" depth below base of box. Install prior to box installation.

2.07 CONTROLS

- A. Controller: Automatic controller, microprocessor solid state control with visible readout display, temporary override feature to bypass cycle for inclement weather, timer for a 4 station system, programmable for 7 days in quarter hour increments, with automatic start and shutdown.
 - 1. Two sensor inputs available. All controllers shall be accompanied by a rain sensor and a flow sensor.
 - 2. Flow monitoring capabilities.
 - 3. Capable of operating any two programs simultaneously.
- B. Controller Housing: NEMA 250 Type 3; weatherproof, watertight, with lockable access door.
- C. Master Valves: Electric Solenoid; normally open; including required fittings and accessories.
- D. Two-Wire Controller Cable, Decoders, Surge Protection and Wire Connectors:
 - 1. Cable shall be UL approved for direct burial and shall be 14-AWG or larger, as recommended by the manufacturer for the conditions of the project.
 - 2. Two-wire cable shall be manufactured by the controller manufacturer for specific use by that controller.
 - 3. Two-wire decoders and surge protection shall be manufactured by the controller manufacturer for specific use by that controller.
 - a. Only single-station decoders shall be used.
 - 4. All connections shall be made with 3M DBR/Y-6 watertight wire connectors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify location of existing utilities.
- B. Verify that water stub out is available, in proper location, and ready for use.

3.02 PREPARATION

- A. Piping layout indicated is diagrammatic only. Route piping to avoid plants, ground cover, and structures.
- B. The Contractor is responsible for layout and staking of irrigation system components.
- C. Electronic design files will be available to the Contractor upon request, subject to the following conditions:
 - 1. A signed Electronic File Transfer Agreement shall be required from each Contractor requesting the electronic design files prior to distribution.
 - 2. Electronic design files will be distributed as DWG files. The Contractor will be responsible for obtaining the appropriate software to open, analyze, and/or convert these file formats for their own use, and understand the risks and limitations associated with that software.
- D. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system.

3.03 EXCAVATION AND TRENCHING

- A. Excavation shall be sufficient depth and width to permit proper pipe and equipment installation at the elevations intended with ample space for joining.
 - 1. All lines shall have a minimum clearance of 6-inches from each other and from other utilities. Parallel lines shall not be installed directly adjacent or over one another.
- B. Trenches for pipelines shall provide minimum cover from finished grade as follows:
 - 1. Minimum Cover Over Installed Mainline Piping: 18-inches.
 - 2. Minimum Cover Over Installed Lateral Piping: 12-inches.
 - 3. Minimum Cover Over Installed Sleeve Piping: 18-inches.
 - 4. Maximum Cover Over Installed Piping: 24-inches.
- C. Where it is necessary to excavate adjacent to existing trees, the Contractor shall use all possible care to avoid injury to trees and tree roots.
 - 1. Excavation in areas where 2" diameter and larger roots occur shall be done by hand.

2. All roots 2" and larger in diameter directly in the path of pipe or conduit, shall be tunneled under and shall be kept shaded with wet burlap or canvas.
 3. Where a trenching machine is used within driplines of trees having roots smaller than 2" in diameter, the wall of the trench adjacent to the tree shall be hand trimmed, making clean cuts through.
 4. Trenches adjacent to trees shall be backfilled within 24 hours.
- D. Maintain trenches free of debris, material, or obstructions that may damage pipe.

3.04 INSTALLATION

- A. Install pipe, valves, controls, and outlets in accordance with manufacturer's written instructions and details found on plan sheets.
- B. Connect to water source.
- C. Set outlets and box covers at finish grade elevations.
- D. Provide for thermal movement of components in system.
- E. Use threaded nipples for risers to each outlet.
- F. After piping is installed, but before outlets are installed and backfilling commences, open valves and flush system with full head of water.

3.05 PIPING

- A. Install piping free of sags and bends on solid subbase, uniformly sloped without humps or depressions.
- B. Cap or plug openings as pipeline is assembled to prevent entrance of dirt or obstruction. Remove caps or plugs only when necessary to continue assembly. Clean dirt and debris from inside and outside of pipe and fittings before assembly.
- C. Install groups of pipes parallel to each other, spaced to permit valve servicing.
- D. Install fittings for changes in direction and branch connections.
- E. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.
- F. Install piping in sleeves under parking lots, roadways, and sidewalks in sleeves made of Schedule PVC pipe and socket fittings, and solvent-cemented joints.

3.06 JOINT CONSTRUCTION

- A. Join threaded pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to pipe threads.
 2. Do not use pipe or pipe fittings with threads that are damaged.
- B. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Pressure Piping: Join schedule number, ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 3. PVC Nonpressure Piping: Join according to ASTM D2855.

3.07 VALVE INSTALLATION

- A. Install where shown on plans and group together in straight lines where practical. Set valves boxes to align with adjacent site features (walks, curbs, etc.). Limit one valve per box.
- B. Locate valves no closer than 12-inches from walk edges, building and walls. Install valve box parallel or perpendicular to walk, curb, or edge.
- C. Install in planting areas where possible.

3.08 DRIP IRRIGATION INSTALLATION

- A. Install dripline below landscape mulch and weed barrier fabric, if applicable.
- B. Install dripline with emitters facing upward or downward. Offset emitters to form a triangular pattern throughout the tubing layout.
- C. Coordinate dripline installation with planting so that dripline runs over the top of all rootballs. Minimum of one emitter at each perennial/ornamental grass, minimum of two per shrub, and minimum of four per tree.
- D. Connect drip tubing with barbed fittings.
- E. Install drip kits with pressure reducing filter horizontally level, below grade in a valve box. The position of the filter shall be off-center to allow for removal of the filter element for periodic servicing.
- F. Install air/vacuum relief valves below grade and at the highest elevation within each zone. Depending on the site conditions and tubing layout, multiple air/vacuum relief valves may be required. Place the valve within a round valve box.
- G. Install flush valves horizontally level and below grade at each exhaust header. Locate in a valve box with a minimum of 1 cu. ft. of drain rock.

3.09 CONTROLLER AND ELECTRICAL CONNECTIONS

- A. Install control wire/cable in same trench as irrigation piping wherever possible. Place wire/cable in trench adjacent to, or below, mainlines but not above. Install wire with slack to allow for thermal expansion and contraction. Install expansion coils at zone valves long enough so valve bonnet may be removed for maintenance. Where necessary to run wire or cable in a separate trench, provide a minimum cover of 24".
 - 1. Make splices only at valves, unless otherwise unavoidable. Locate all field splices on the as-built drawing.
 - 2. Hard wire power to controller. All connections and installations shall meet applicable electrical codes. All wire not buried to be installed in conduit.
- B. Control system shall be properly grounded per manufacturer's published recommendations
 - 1. At a minimum, include surge protection at every 500 feet, or every 8 decoders, whichever is smaller.

3.10 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 014000 - Quality Requirements.
- B. Tests and Inspections:
- C. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 1. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. System is acceptable if no leakage or loss of pressure occurs during test period.

3.11 BACKFILLING

- A. Backfill only after piping has been tested, reviewed, and accepted.
- B. Excavated soil may be used as backfill. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, trash, and other extraneous matter. In rocky soil provide sand backfill material around and under the piping and risers by hand to a height of 6" above all piping. Backfill shall be compacted to 95% minimum density by mechanical tamping. Trench must be free of water during backfilling operation.
- C. All backfill around valves and risers shall be mechanically compacted to 95% minimum density.
- D. Backfill trench and compact to specified subgrade elevation. Protect piping from displacement.

3.12 SYSTEM STARTUP

- A. Prepare and start system in accordance with manufacturer's instructions.
- B. Contractor shall review controller programming and update or change program throughout establishment period. Programming must conform to local watering restrictions. Contractor is liable for fines associated with watering during restricted times.
- C. Perform a coverage test to confirm water coverage and operation of the system is adequate for planting, without areas of excessive flooding or dry spots. If the irrigation system is determined by the Owner to be inadequate due to poor workmanship or materials, it shall be replaced or repaired at Contractor's expense and both pressure and coverage tests repeated until accepted.

3.13 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean surrounding areas of construction debris.

3.14 CLOSEOUT ACTIVITIES

- A. Instruct Owner's personnel in operation and maintenance of system, including adjusting of controller timing. Use operation and maintenance data as basis for demonstration.

3.15 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

**SECTION 328423
UNDERGROUND SPRINKLERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe and fittings, valves, sprinkler heads, emitters, and accessories.
- B. Control system.
- C. Coordinate work with an existing undocumented irrigation system; perform operational testing prior to any site disturbance activities.
 - 1. Ensure existing zones that span the limit of disturbance are maintained in an operating condition during construction.

1.02 DEFINITIONS

- A. Lateral Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.
- B. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.03 PERFORMANCE REQUIREMENTS

- A. Design, furnish and install a complete automatic irrigation system for the turf areas as shown on the plans. Work to include layout, trenching, piping, backfill, valves, valve boxes, risers, emitters and controls.
- B. Delegated Design: design 100 percent head-to-head coverage irrigation system, including comprehensive analysis by a qualified irrigation designer, using performance requirements and design criteria indicated.
 - 1. Overspray onto buildings, sidewalks and parking or driveways is not permitted.
- C. Minimum Working Pressures; pipe shall be selected to accommodate twice the anticipated water pressure or pipe indicated below, whichever is greater.
 - 1. Main Piping: 200 psi
 - 2. Lateral Piping: 100 psi

1.04 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds; 2020.
- C. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- D. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2020.
- E. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2023.
- F. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2023.
- G. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.
- H. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe; 2021.
- I. ASTM D2672 - Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement; 2020.

- J. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.
- K. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019.
- L. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2018.
- M. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings; 2021.
- N. ASTM F1970 - Standard Specification for Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems; 2019.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with site backfilling, landscape grading and delivery of plant life.
- B. Preinstallation Meeting: Convene one week prior to commencing work of this Section.

1.06 FIELD DIMENSION AND LAYOUT

- A. The Contractor is responsible for furnishing, setting, and marking all line, grade, and location stakes including offsets and general construction staking.
- B. Electronic design files WILL be available to the Contractor upon request, subject to the following conditions:
 - 1. A signed Electronic File Transfer Agreement shall be required from each Contractor requesting the electronic design files prior to distribution.
 - 2. Electronic design files will be distributed as DWG files. The Contractor will be responsible for obtaining the appropriate software to open, analyze, and/or convert these file formats for their own use, and understand the risks and limitations associated with that software

1.07 SUBMITTALS

- A. Product Data: The Contractor shall submit catalog information of all equipment for approval.
- B. Delegated Design Submittal: Comply with the following performance requirements and design criteria, including analysis data.
 - 1. Water service point-of-connection and pressure.
 - 2. Zone control valves.
 - 3. Piping layout and sizes.
 - 4. Sprinkler/emitter locations, head types and area of coverage.
 - 5. Schedule of irrigation equipment indicating type, model, size and quantity.
 - 6. Typical irrigation installation details.
- C. Qualification Data for 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. Operation and Maintenance Data:
 - 1. Provide instructions for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer's parts catalog.
 - 2. Provide schedule indicating length of time each valve is required to be open to provide a determined amount of water.
- E. Statement of Warranty: Describing an understanding of the required warranty. Provide name and phone number for responsible contact. Include product warranties for each component warranted by manufacturer.
- F. Record Documents: The Contractor is responsible for documenting changes to the design.

1. Record work that is installed differently than shown on the construction shop drawings. Record pipe and wiring network alterations and location changes to equipment. Keep documents current. Do not permanently cover work until as-built information is recorded.
2. Turn over the "Record Drawings" to the Landscape Architect. Completion of the Record Drawings will be a prerequisite for irrigation system substantial completion and final payment.

1.08 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: An installer that has successfully installed projects of similar scope and size. with minimum three years of experience.
 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.09 WARRANTY

- A. The purpose of this guarantee/warranty is to ensure that the Owner receives irrigation materials of prime quality, installed and maintained in a thorough and careful manner.
- B. For a period of one year from date of Project Substantial Completion, the Contractor will guarantee/warranty irrigation materials, equipment, and workmanship against defects. Fill and repair depressions. Restore landscape or structural features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by a defective item. Make repair within seven days of notification from the Owner's Representative.
 1. Contract documents govern replacements identically as with new work. Make replacements at no additional cost to the contract price.
 2. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.
- C. Provide winterization and spring start up services at no additional charge during the warranty period.

PART 2 PRODUCTS

2.01 IRRIGATION SYSTEM

- A. Electric solenoid controlled underground irrigation system, with pressure blow-out drain.
- B. Manufacturers:
 1. Rain Bird Sales, Inc; ____: www.rainbird.com/#sle.
 2. Toro Company; ____: www.toro.com/#sle.
 3. Hunter Industries: www.hunterindustries.com.

2.02 PIPE MATERIALS

- A. PVC Pipe: ASTM D1785; Schedule 40; solvent welded sockets.
- B. PVC Fittings:
 1. PVC Socket Fittings: ASTM D2466, Schedule 40.
 2. PVC Threaded Fittings: ASTM D2464, Schedule 80.
 - a. All threaded connections shall be sealed using Teflon tape or paste.
- C. Pipe Risers at Valves: Schedule 80 PVC nipples.
- D. Solvent Cement: ASTM D2564 for PVC pipe and fittings. Include primer according to ASTM F656.
- E. Sleeves: Sleeves for pipes passing beneath paving shall conform to ASTM D2241, Schedule 40. Minimum diameter of 2 inch or 2 sizes larger than pipe scheduled to pass through them.
- F. PE Pipe with Controlled ID: ASTM D2239, PE4710 compound; SIDR 15.
 1. Insert Fittings for PE Pipe: ASTM D2609, nylon or propylene plastic with barbed ends. Include stainless steel bands or other fasteners.

2.03 OUTLETS

- A. Rotor Sprinkler Head: Gear drive mechanism; fully adjustable for flow and pressure; size as indicated; with letter or symbol designating degree of arc and arrow indicating center of spray pattern.
 - 1. Description:
 - a. Body Material: ABS
 - b. Nozzle: ABS
 - c. Retraction Spring: Stainless steel.
 - 2. Capacities and Characteristics:
 - a. Flow varies as required to provided uniform distribution within each irrigation zone.
 - b. Pop-up Height: 4-inches to 5-inches, aboveground to nozzle.
 - c. Arc: Variable, adjustable dependent upon location. Adjustable heads are not acceptable for use in 360 degree applications.
 - d. Inlet: bottom inlet, NPS 3/4".
- B. Pop-Up Spray Type Sprinkler Head:
 - 1. Description:
 - a. Body Material: ABS
 - b. Nozzle: ABS, color coded.
 - c. Retraction Spring: Stainless steel.
 - d. Pattern: Fixed, with flow adjustment.
 - 2. Capacities and Characteristics:
 - a. Flow: Varies as required to provide uniform distribution within each irrigation zone.
 - b. Pop-up Height: 4-inches, aboveground to nozzle.
 - c. Pressure-Regulated to 30 PSI.
 - d. Arc: Full, half, quarter, or variable pattern nozzle as required to minimize overspray.
 - e. Radius: Varies, up to 15 feet.
 - f. Inlet: NPS 1/2.
- C. Pop-Up Rotary Nozzle Sprinkler Head:
 - 1. Description:
 - a. Body Material: ABS
 - b. Nozzle: ABS, color coded.
 - c. Retraction Spring: Stainless steel.
 - d. Pattern: Multi-stream, multi-trajectory.
 - 2. Capacities and Characteristics:
 - a. Flow: Varies as required to provide uniform distribution within each irrigation zone. As the arc and radius are adjusted, the flow rate shall change to maintain matched precipitation.
 - b. Pop-up Height: 4-inches, aboveground to nozzle.
 - c. Pressure-Regulated to 40 PSI.
 - d. Arc: Infinitely adjustable arc from 45° to 105°, 90° to 210°, or 210° to 270° using the stainless steel arc ring. The full-circle sprinkler shall irrigate a full 360°.
 - e. Radius: Varies, up to 30 feet.
 - f. Inlet: NPS 1/2. Use of side inlet is not allowed in freezing climates.
- D. Landscape Dripline:
 - 1. Description:
 - a. Flexible, linear low-density polyethylene, ultraviolet (UV) resistance.
 - b. Pressure compensating emitters factory molded into tubing at set intervals to deliver water at 10-60 PSI
 - c. Fittings: UV-resistant, glass reinforced polypropylene
 - 2. Capacities and Characteristics:
 - a. Emitter spacing: _____.

- b. Emitter flow: _____.
 - c. Line spacing: as indicated and as determined through delegated design for project application.
 - d. Flush cap at the end of each run for winterization.
 - e. One operation indicator per zone shall provide a visual indication of system operation.
 - f. Air relief valve at the high point of each zone.
3. Pressure Regulating Filter:
- a. Capable of operating between 20 - 120 PSI
 - b. The downstream pressure shall be 25 or 40 PSI regardless of variations in upstream pressure.
 - c. 150 mesh stainless steel filter, removable cap for service and cleaning.
- E. Quick Coupler: Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.
1. Locking-Top Option: Vandal-resistant locking feature. Include one (1) matching key(s).
 2. Delegated design Placement and Quantity: include a minimum of one (1) quick couplers in the irrigation plan. Coordinate location with Owner.
- F. Swing Joints: Pre-Fabricated PVC sprinkler riser for connections between water service and sprinkler head(s) with ACME thread and O-ring sealed rotating sections as per ASTM F2768, for leak free height adjustment and impact absorption.
1. Reference Standard: ASTM D1784, ASTM F1970.
 2. PVC Type I, Cell Classification 1254-B.
 3. CWP Rating: 315 psig, ASTM D3139.
 4. O-Ring Material: Buna.
 5. Rotating Section Threads: ACME with O-ring seal.
 6. Size swing joints to match inlet, NPS 1/2 to NPS 1 inch.

2.04 VALVES

- A. Products:
1. _____.
 2. _____.
- B. Gate Valves: Bronze construction non-rising stem.
- C. Automatic Control Valves: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, adjustable pressure regulation, and operated by 24-V ac solenoid
- D. Valve Box and Cover: with open bottom and openings for piping; designed for installing flush with grade.
1. Size: As required for valves and service but no smaller than the following:
 - a. 15"x21"x12" deep for control valves.
 - b. 10" diameter for quick coupling or isolation valves.
 - c. 6" diameter for drip irrigation flush valves.
 2. Shape: Rectangular for control valves, circular for specialties as indicated on details.
 3. Material: PE or ABS.
 4. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/8 inch minimum to 3/4 inches maximum, to 6" depth below base of box. Install prior to box installation.

2.05 CONTROLS

- A. Products:
- B. Irrigation systems shall be equipped with controllers that contain the following features:
1. Multiple programming capabilities, capable of storing a minimum of three different programs to allow for separate schedules.

2. Multiple start times (cycling, cycle/soak, stackable start times), capable of a minimum of three different start times to allow for multiple irrigation cycles on the same zone for areas prone to runoff.
 3. Variable run times, capable of varying run times from 1 minute to 60 minutes.
 4. Variable scheduling, capable of interval scheduling (minimum of 14 days) to allow for watering on even day, odd day, calendar day and interval scheduling.
 5. Percent adjust (water budget) feature shall include a percent up/down adjust feature that permits the user to increase or decrease the run-times for each zone by a prescribed percentage, by means of one adjustment without modifying the settings for that individual zone.
 6. Capable to accept external soil moisture and/or rain sensors.
 7. Non-volatile memory or self-charging battery circuit.
 8. Complete shutoff capability for total cessation of outdoor irrigation.
- C. Smart Water Application Technologies (SWAT): Provide controllers that comply with the most current definitions and testing protocols published by SWAT for:
1. Controllers, Climate-based
- D. Rain sensors, equip irrigation system with rain-sensor.
- E. Two-Wire Controllers:
1. Wire Conductors: 14 AWG with solid copper conductors; insulated for direct burial and compatible with control system specified.
 2. Decoders shall be compatible with control system and provided in single-station configurations.
 3. All connections shall be made with 3M DBR/Y-6 watertight wire connectors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify location of existing utilities.
- B. Verify that water stub out is available, in proper location, and ready for use.

3.02 PREPARATION

- A. Piping layout indicated is diagrammatic only. Route piping to avoid plants, ground cover, and structures.
- B. Layout and stake locations of system components.
- C. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system.

3.03 TRENCHING

- A. Trench Size:
 1. Minimum Cover Over Installed Mainline Piping: 18-inches.
 2. Minimum Cover Over Installed Lateral Piping: 12-inches.
 3. Minimum Cover Over Installed Sleeve Piping: 18-inches.
 4. Maximum Cover Over Installed Piping: 24-inches.
- B. Trench to accommodate grade changes.
- C. Maintain trenches free of debris, material, or obstructions that may damage pipe.

3.04 INSTALLATION

- A. Install pipe, valves, controls, and outlets in accordance with manufacturer's written instructions and details found on plan sheets.
- B. Connect to water source.
- C. Set outlets and box covers at finish grade elevations.
- D. Provide for thermal movement of components in system.

- E. Use threaded nipples for risers to each outlet.
- F. After piping is installed, but before outlets are installed and backfilling commences, open valves and flush system with full head of water.

3.05 PIPING INSTALLATION

- A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
- B. Install piping free of sags and bends.
- C. Install groups of pipes parallel to each other, spaced to permit valve servicing.
- D. Install fittings for changes in direction and branch connections.
- E. Install expansion loops in control-valve boxes for plastic piping.
- F. Lay piping on solid subbase, uniformly sloped without humps or depressions.
- G. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.
- H. Install piping in sleeves under parking lots, roadways, and sidewalks in sleeves made of Schedule PVC pipe and socket fittings, and solvent-cemented joints.

3.06 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.
- E. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Pressure Piping: Join schedule number, ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 - 3. PVC Nonpressure Piping: Join according to ASTM D2855.

3.07 SPRINKLER INSTALLATION

- A. Install sprinklers after hydrostatic test is completed.
- B. Install sprinklers at manufacturer's recommended heights.
- C. Install sprinklers utilizing factory pre-fabricated swing joints or swivel joints.
- D. Locate part-circle sprinklers to maintain a minimum distance of 4 inches from walls and 2 inches from other boundaries unless otherwise indicated.

3.08 DRIP IRRIGATION INSTALLATION

- A. Install drip tubes with direct-attached emitters on ground, conceal with landscape mulch.
- B. Install air relief valves at highest point in valve box within each drip zone.
- C. Install flush cap at lowest point(s) in valve box within each drip zone.

3.09 CONTROL WIRE

- A. Wire Splices: No splices between controller and valve without prior approval and documentation on as-built drawings.
- B. Install control cable in same trench as irrigation piping and at least 2-inches below, or beside, piping. Bundle wires together and tape at 10 foot intervals. Provide an 18-inch expansion loop at all sleeve ends, direction changes and at every valve box. Allow expansion coils at zone valves long enough so valve bonnet may be removed for maintenance.
- C. Control system shall be properly grounded per manufacturer's published recommendations and at a minimum shall include surge protection at every 500 feet, or every 8 decoders, whichever is smaller.

3.10 FIELD QUALITY CONTROL

- A. Tests and Inspections:
- B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 1. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Performance Testing: After system is 100% installed, perform a coverage test to determine whether water coverage and operation of the system is adequate for planting, without areas of excessive flooding, dry spots, areas of insufficient overlap, or excessive overspray. If the irrigation system is determined by the Owner to be inadequate due to poor workmanship or materials, it shall be replaced or repaired at Contractor's expense and both pressure and coverage tests repeated until accepted.

3.11 BACKFILLING

- A. Excavated soil may be used as backfill. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, trash, and other extraneous matter. In rocky soil provide sand backfill material around and under the piping and risers by hand to a height of 6" above all piping. Backfill shall be compacted to 95% minimum density by mechanical tamping. Trench must be free of water during backfilling operation.
- B. All backfill around valves and risers shall be mechanically compacted to 95% minimum density.
- C. Backfill trench and compact to specified subgrade elevation. Protect piping from displacement.

3.12 SYSTEM STARTUP

- A. Prepare and start system in accordance with manufacturer's instructions.
- B. Contractor will review controller programming and update or change program throughout establishment period. Programming must conform to local watering restrictions. Contractor is liable for fines associated with watering during restricted times.
- C. Adjust control system to achieve time cycles required.
- D. Adjust head types for full water coverage as directed.

3.13 CLOSEOUT ACTIVITIES

- A. Instruct Owner 's personnel in operation and maintenance of system, including adjusting of controller timing. Use operation and maintenance data as basis for demonstration.

3.14 MAINTENANCE

- A. Provide one complete spring start-up and a fall shutdown by installer, at no extra cost to Owner.

**SECTION 329119
LANDSCAPE GRADING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Topsoil placement.
- B. Finish grading.

1.02 RELATED REQUIREMENTS

- A. Section 311000 - Site Clearing.
- B. Section 312200 - Grading.
- C. Section 312333-Trenching and Backfilling
- D. Section 329219 - Seeding.
- E. Section 329223 - Sodding.
- F. Section 321443 - Porous Unit Paving (Grasspave2)

1.03 REFERENCE STANDARDS

- A. ASTM D5268 - Standard Specification for Topsoil Used for Landscaping and Construction Purposes; 2019, with Editorial Revision (2020).

1.04 FIELD CONDITIONS

- A. Place topsoil during dry weather.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: Comply with ASTM D5268.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify grading and intended elevations are as indicated on drawings.
- B. Verify absence of standing or ponding water.

3.02 TOPSOIL PLACEMENT

- A. Uniformly distribute and spread topsoil.
- B. Place topsoil in areas where seeding, sodding, and planting as indicated on drawings.
- C. Place topsoil to the following compacted thicknesses:
 - 1. Areas Indicated Seeded with Grass: 6 inches.
 - 2. Areas Indicated as Sodded: 4 inches.
 - 3. Shrub Beds: 18 inches.
 - 4. Flower Beds: 12 inches.

3.03 FINISH GRADING

- A. Maintain profiles and contour of subgrade.
- B. Remove roots, weeds, rocks, and foreign material while spreading. No objects (e.g larger than 1/2 should remain.
- C. Maintain uniform topsoil thickness.
- D. Lightly compact placed topsoil.
- E. Maintain stability of topsoil during inclement weather. Replace eroded topsoil.

3.04 TOLERANCES

- A. Topsoil Thickness: 1/2 inch plus/minus.

3.05 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove unused topsoil. Grade stockpile area to prevent standing water.
- C. Leave stockpile area and site clean and raked, ready to receive landscaping

3.06 PROTECTION

- A. Protect from stormwater runoff and subsequent construction operations.
- B. Do not permit traffic until established.

**SECTION 329219
SEEDING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Soil preparation.
- B. Seeding Hydroseeding, mulching and fertilizer.
- C. Erosion Control.
- D. Establishment.

1.02 RELATED REQUIREMENTS

- A. Section 312200 - Grading: Preparation of subsoil topsoil in preparation for the work of this section.
- B. Section 329119 - Landscape Grading: Topsoil placement and finish grading.

1.03 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Growing Season: A growing season is considered from September 1 to October 31.
- C. 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.
- D. 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.
- E. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil or imported topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

1.04 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.
- C. Product tags to confirm quantity installed of the following products. Payment will not be approved until product tags have been received and approved by the Landscape Architect.
 - 1. Seed.
 - 2. Fertilizer.
 - 3. Fiber Mulch.
- D. Qualification Data: For qualified 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 person.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site
 - 2. Pesticide Applicator: State licensed, commercial.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and grasses during a calendar year. Submit before expiration of required initial maintenance periods.

- F. Establishment Plan. Describing an understanding of the required establishment period including anticipated dates for mowing, pest control, observation and overseeding.

1.05 QUALITY ASSURANCE

- A. Installer's Field Supervision: Require installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Pre-installation Conference: Schedule a pre-installation meeting to review soil preparation and grading with the Contractor and Landscape Architect prior to seeding.
- C. Seasonal limitations have been designated below. If seasonal limitations cannot be met, then an alternate soil stabilization practice must be used. Payment will be made to the Contractor for these alternate stabilization practices if caused by the conditions out of the Contractor's control and not the result of the Contractor's negligence or inability to keep the Project on schedule.
 - 1. Spring: March 1 to April 30
 - 2. Fall: September 1 to October 31
 - 3. Dormant: November 1 to the end of February

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.01 SEED MIXTURE

- A. Seed Mixture -Meadow:
 - 1. Turf Type Tall Fescue: 20-30 percent (Dwarf or Low-Mow Varieties)
 - 2. Fine Fescue: 70-80 percent (Creeping Red, Chewings, Hard, or Sheep Fescue)

2.02 ACCESSORIES

- A. Microbial Inoculant
 - 1. Inoculate seed prior to planting at rate recommended by manufacturer for seed type specified.
- 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. 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: 12-24-12.
 - 2. Application rate: 7.0 lb/1000 SF
- D. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
- E. 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.
- F. Erosion Fabric: excelsior fibers manufactured from aspen matting, open weave.
 - 1. Curlex II CL
American Excelsior Company
www.curlex.com
 - 2. Excel SS-2

Western Excelsior Corporation
www.westernexcelsior.com

3. SB150
North American Green
www.nagreen.com

PART 3 EXECUTION

3.01 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.
- 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.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings 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. Seedbed Preparation
 1. Kill existing weed growth with non-selective herbicide a minimum of two weeks prior to planting date. Apply a second application as necessary a minimum of 24 hours prior to seeding or sodding.
 - a. Apply at rate recommended by manufacturer.
 2. Loosen soil to a depth of 4-inches.
 3. Remove stones larger than 1-1/2 inches. in any dimension and sticks, roots, trash, and other extraneous matter.
 - a. 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. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.03 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Apply fertilizer no more than 48 hours prior to seeding.
- D. Mix thoroughly into upper 2 inches of topsoil.

3.04 MULCHING

- A. Fiber Mulch: Rate of application shall be 2,000 pounds per acre. Areas of excessive thickness of mulch, which will smother grass seedlings, shall be avoided. Mulch shall be placed on a given area as soon as possible or within 48 hours after seeding as a separate operation. The Contractor shall allow the fiber mulch to cure a minimum of 18 hours prior to watering.

3.05 HYDROSEEDING

- A. Apply seeded slurry with a hydraulic seeder at a rate of 2,000 to 3,000 lbs per acre evenly in two intersecting directions.
- B. Do not hydroseed area in excess of that which can be mulched on same day.
- C. Immediately following seeding, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
- D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
- E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.06 EROSION CONTROL BLANKET

- A. Cover seeded slopes where grade is 4:1 or greater with erosion blanket. Contractor is responsible for establishing limits.
- B. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.
- C. Orient erosion control blankets in vertical strips and anchored with staples, at spacing as indicated by manufacturer's written instruction for project application.
- D. Provide 12 inch overlap of adjacent rolls, anchor with a common row of staples.
- E. Overlap horizontal joints between erosion control blankets sufficiently to accommodate a common row of staples with the uphill end on top of the blanket below.
- F. Where exposed to overland sheet flow, bury top end of each section in 6 inch (150 mm) deep excavated topsoil trench. Staple the erosion control blanket to the bottom of the trench. Backfill and compact the trench as required.
- G. Secure outside edges and overlaps at 36 inch intervals with stakes.
- H. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

3.07 ESTABLISHMENT

- A. Provide maintenance during establishment period at no extra cost to Owner; Owner will pay for water.
- B. Begin maintenance immediately after each area is planted and continue until grass is well established and exhibits a vigorous growing condition free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 12-inches by 12-inches, **but not less than 120 days from date of Project Substantial Completion**.
 - 1. When maintenance period has not elapsed before the end of the growing season, or if turf is not fully established, continue maintenance during next growing season.
 - 2. Notify the Landscape Architect in writing upon the termination of required maintenance services. The Contractor shall continue maintenance services until written notification is provided.
- C. Maintain as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Materials and installation methods shall be the same as those used in the original installation.
 - 1. Fill and establish turf in areas where settling occurs.
 - 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
- D. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain height appropriate for species without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. The contractor is required to mow all seeded turf areas one time. Document and notify the Landscape Architect and Owner in writing upon completion.
 1. Neatly trim edges and hand clip where necessary.
 2. Immediately remove clippings after mowing and trimming.
- E. Watering: Where an irrigation system will be installed, maintain the irrigation program to keep turf uniformly moist to a depth of 4 inches. The Contractor may obtain water from Owner's existing water system for use without metering and without payment of use charges. If seeding is performed within the specified seeding windows watering is not required in areas where an irrigation system is not present.
 1. Schedule irrigation to prevent wilting, puddling, erosion, and displacement of seed or mulch.
 2. Apply water with irrigation system at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- F. Roll surface to remove minor depressions or irregularities.
- G. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
 1. 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.
 2. Broadleaf herbicide application: Apply a broadleaf herbicide application once turf is established, or as directed by Landscape Architect, when grass is dry.
- H. Immediately reseed areas that show bare spots.
- I. Protect seeded areas with warning signs during maintenance period.

3.08 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Clean up any hydroseeding overspray on adjacent hardscapes, including but not limited to sidewalks, roads, building walls, and other surfaces.
- C. If not already installed, erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

**SECTION 329223
SODDING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Soil Preparation.
- B. Fertilizing.
- C. Sod installation.
- D. Turf establishment.

1.02 RELATED REQUIREMENTS

- A. Section 329119 - Landscape Grading: Topsoil placement and finish grading.

1.03 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Growing Season: A growing season is considered March 1 to October 1.
- C. 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.
- D. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil or imported topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- 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.

1.04 REFERENCE STANDARDS

- A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding; 2006.

1.05 SUBMITTALS

- A. Certificate: Certify grass species and location of sod source.
- B. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and grasses during a calendar year. Submit before expiration of required initial establishment period.

1.06 QUALITY ASSURANCE

- A. Sod Producer: Company specializing in sod production and harvesting with minimum five years' experience, and certified by the State California .
- B. Installer's Field Supervision: require Installer to maintain an experienced full-time supervisor on Projectd site when work is in progress.
- C. Pre-installation Conference: Schedule a pre-installation meeting to review soil preparation and grading with the Contractor and Landscape Architect prior to seeding.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect exposed roots from dehydration.
- B. Do not deliver more sod than can be laid within 24 hours.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sod: TPI (SPEC), Certified Turfgrass Sod quality; cultivated grass sod; type indicated below; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft. Minimum age of 18 months, with root development that will support its

own weight without tearing, when suspended vertically by holding the upper two corners.

1. Bermuda Grass Type: 60-70% percent
 2. Fescue Grass Type: 30-40% percent
- B. Fertilizer: 16-20-10; recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.

2.02 ACCESSORIES

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition
1. Composition: 16-20-10, or approved equal.
 2. Application rate: 7.0 lb/1000 SF
- B. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
- C. 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.

PART 3 EXECUTION

3.01 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.
- 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.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings 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. Prepare surface soil
1. Kill existing weed growth with non-selective herbicide a minimum of two weeks prior to planting date. Apply a second application as necessary a minimum of 24 hours prior to seeding or sodding.
 - a. Apply at rate recommended by manufacturer.
 2. Loosen soil to a depth of 4-inches.
 3. Remove stones larger than 1-1/2 inches. in any dimension and sticks, roots, trash, and other extraneous matter.
 - a. 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. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.03 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to installation of sod.
- C. Apply fertilizer no more than 48 hours before laying sod.
- D. Mix thoroughly into upper 2 inches of topsoil.

3.04 LAYING SOD

- A. Moisten prepared surface immediately prior to laying sod.
- B. Lay sod immediately after delivery to site to prevent deterioration.
- C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.
- D. Where new sod adjoins existing grass areas, align top surfaces.
- E. Where sod is placed adjacent to hard surfaces, such as curbs, pavements, etc., place top elevation of sod 1/2 inch below top of hard surface.
- F. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.
- G. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

3.05 ESTABLISHMENT

- A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
- B. Maintain sodded areas immediately after placement until grass is well established and exhibits a vigorous growing condition **but not less than 30 days from date of Project Substantial Completion**.
 - 1. At the end of the establishment period, an inspection will be made to determine if the sod is alive and growing. If this cannot be determined, the Contractor shall have the option of maintaining the sod until it can be determined or replacing the sod. Such maintenance or replacement shall be at the expense of the Contractor. Replaced sod shall be watered as required for original sod at the expense of the Contractor. If it is determined at the end of the maintenance period the sod is well rooted, alive and growing, the Contractor shall be relieved of the responsibility for extended maintenance.
- C. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any single mowing.
- D. Neatly trim edges and hand clip where necessary.
- E. Immediately remove clippings after mowing and trimming.
- F. Water to prevent grass and soil from drying out. Where an irrigation system will be installed, maintain the irrigation program to keep turf uniformly moist to a depth of 4 inches. The Contractor may obtain water from Owner's existing water system for use without metering and without payment of use charges.
 - 1. Schedule irrigation to prevent wilting, puddling, or erosion.
 - 2. Adjust irrigation schedule to reduce watering as turf is established.
- G. Roll surface to remove irregularities.
- H. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

- I. Immediately replace sod in areas that show deterioration or bare spots.
- J. Protect sodded areas with warning signs during maintenance period.

**SECTION 329300
PLANTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. New trees, plants, and ground cover.
- B. Relocated trees, plants, and ground cover.
- C. Mechanized Tree Spade Planting.
- D. Mulch and Fertilizer.
- E. Plant establishment.
- F. Tree Pruning.

1.02 RELATED REQUIREMENTS

- A. Section 32119 - Landscape Gr: Topsoil placement and finish grading.
- B. Section 329410 - Landscape Edging
- C. Section 321540 - Landscape Boulders

1.03 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Growing Season: A growing season is considered to be May 1 to October 1.
- 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 or imported topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. 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.
- H. Weeds: Any plant life not specified or scheduled.

1.04 REFERENCE STANDARDS

- A. ANSI/AHIA Z60.1 - American National Standard for Nursery Stock; 2014.
- B. ANSI A300 Part 1 - American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices (Pruning); 2017.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Mulch
 - 2. Weed Barrier
- B. 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.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to project site.

2. Pesticide Applicator: State licensed, commercial.
- C. Maintenance Agreement: Statement of required maintenance period, duties to be performed, name and contact information of individual responsible for overseeing maintenance services.
- D. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.
- E. Statement of Warranty. Describing an understanding of the required warranty. Provide name and phone number for responsible contact.

1.06 QUALITY ASSURANCE

- A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Pre-installation Conference: Schedule a pre-planting meeting to review preparation and planting requirements with the Landscape Architect and Contractor prior to planting. All plants, trees and shrubs shall be planted in accordance with all the drawings and specifications included in the plans.
- D. Planting Restrictions: Plant during one of the following periods.
 1. Spring Planting: February 1 to April 30.
 2. Fall Planting: September 15 to November 15.
 3. Planting outside the specified windows is permitted only with written approval from the Landscape Architect. Any plants installed without approval, outside this timeframe shall have their warranty period extended to twice the duration specified in Section 1.09.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- B. Protect and maintain plant life until planted.
 1. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
 2. Handle planting stock by root ball.
 3. 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.
 4. Trees may not be stored on site for more than 24 hours prior to planting without prior approval and installation of moisture retaining cover or bedding around all root balls.

1.08 FIELD CONDITIONS

- A. Do not install plant life when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.
- B. Do not install plant life when wind velocity exceeds 30 mph.

1.09 WARRANTY

- A. Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship or growth within the specified warranty period.
- B. Failures include, but are not limited to: death and unsatisfactory growth, lack of adequate maintenance and damage from falling or blowing over. The Contractor will be responsible to remove all dead plantings and trees immediately upon notification from the Landscape

Architect, even if the replacement is not immediate. This requirement applies during the warranty period as well.

- C. All plants, trees and shrubs shall be **warranted for ONE YEAR from date of Project Substantial Completion** . At the end of the warranty period the Landscape Architect shall make an inspection of the project and dead, unhealthy, or otherwise not acceptable plants, trees, and shrubs shall be replaced by the Contractor at no additional cost to the Owner.
 - 1. Notify the Owner and Landscape Architect in writing immediately upon completion of any warranty replacement plantings. For replacements after the initial establishment period has expired the Contractor shall water replacement plants for one week, after which the Owner assumes responsibility for watering replacement plants. If written notice is not provided the Contractor shall continue to water replacement plants until notice requirements are fulfilled.
 - 2. An intermediate warranty inspection may occur prior to the one year warranty expiration. Replacement is required within 60 days of the intermediate warranty inspection.
 - a. If a plant replaced during the intermediate warranty period dies prior to the final warranty the contractor is not required to install a second replacement without additional compensation. Requests for additional compensation must be approved prior to proceeding with the work.
 - 3. Notify the Landscape Architect in writing with any concerns regarding Owner Maintenance of plant material during the warranty period.
- D. Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.
- E. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.01 PLANTS

- A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.
- B. General: All plants, trees and shrubs shall conform to or exceed minimum quality standards as defined by the American Nursery and Landscaping Association, current edition of ANSI Z60.1, and shall be purchased from a licensed Landscape Nursery. Plants, trees and shrubs furnished shall be of the same genus, species, cultivar and size as specified in the plans. Species and variety may be substituted only by the approval of the Landscape Architect. Each plant, tree and shrub shall have an identification label, removed after the Substantial Completion inspection.
- C. All furnished plants must have been established in their specified container for a minimum of 90 days prior to planting. Any plants that have been recently potted within the past 90 days prior to arriving on-site, will not be accepted.
- D. 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.

2.02 SOIL AMENDMENT MATERIALS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition.
 - 1. Composition: 6-24-24.
 - 2. Application rate: 7.0 lb/1000 SF

2.03 MULCH & ROCK MATERIALS

- A. Cobble Mulch: Rounded riverbed cobble or smooth-faced stone.
 - 1. Size Range: Uniformly graded; 5 inches maximum, 3 inches minimum.
 - 2. Color: Readily available natural gravel color range.

- B. Decorative Gravel Mulch: Lava rock gravel
 - 1. Size Range: Uniformly graded; 1 inches maximum, 3/4 inches minimum
 - 2. Color: Readily available natural black gravel color range
- C. Pathway Gravel: Chip gravel for pathway and storage area
 - 1. Size Range: Pathway Chip 3/8"
 - 2. Color: Readily available natural gravel color range
- D. Organic Mulch: Shredded bark mulch.
 - 1. Color: undyed natural wood.
 - 2. Particle size and consistency: a general mixture of fibers 3 inches in length or less.
 - 3. Remove any large mulch chunks that do not meet the requirements above.
- E. Weed Barriers
 - 1. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric.
 - 2. Available Products:
 - a. DeWitt Pro 5
 - b. SRW Products Pro Plus V
 - c. Or approved equal.

2.04 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. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.
- C. Pre-Emergent Herbicide: Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

2.05 ACCESSORIES

- A. Treegator slow release watering bag, or approved equal; www.treegator.com
 - 1. Size: 20 Gallon
 - 2. Supply and install one per tree.

PART 3 EXECUTION

3.01 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.
- 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.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings 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. Prepare surface soil:
 - 1. Kill existing weed growth with non-selective herbicide a minimum of two weeks prior to planting date. Apply a second application as necessary a minimum of 24 hours prior to planting.
 - a. Apply at rate recommended by manufacturer.
 - 2. Loosen surface soil to a depth of at least 6 inches.
 - 3. Remove stones larger than 1-1/2 inches. in any dimension and sticks, roots, trash, and other extraneous matter.
 - a. 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. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.03 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after initial raking of topsoil.
- C. Mix thoroughly into upper 2 inches of topsoil.

3.04 TREE AND SHRUB PLANTING

- A. Place plants as indicated.
- B. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.
 - 1. Expose root flare; root flare may have been buried in the root ball during growing or tree harvesting operations.
- C. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- D. Excavate planting pits with sides sloping inward at a 30-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 five times as wide as ball diameter.
 - 2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 - 3. Hand dig tree planting pits when in close proximity to existing utilities.
- E. Set 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. Balled and Burlapped: 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. Container-Grown: Carefully remove root ball from container without damaging root ball or plant.

4. 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.
 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.
- G. Set plants vertical.
- H. Remove non-biodegradable root containers.

3.05 MECHANIZED TREE SPADE PLANTING

- A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI/AHIA Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
- B. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- C. Cut exposed roots cleanly during transplanting operations.
- D. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.
- E. Where possible, orient the tree in the same direction as in its original location.

3.06 PLANT SUPPORT

- A. Trunk stabilization is not required unless deemed necessary by the Landscape Architect to maintain the tree in an upright position. Tree staking may be requested at any time between planting and expiration of the plant warranty period.
 1. Upright Staking and Tying: Use three stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend one-third of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
 2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.07 TREE PRUNING

- A. Prune trees as recommended in ANSI A300 Part 1.
- B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.08 PERENNIAL AND ORNAMENTAL GRASS PLANTING

- A. Set out and space perennial plants and ornamental grasses according to plan and in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- E. Water thoroughly within two hours after planting, taking care not to cover plant crowns with wet soil.
- F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.09 PLANTING AREA MULCHING

- A. Weed barrier fabric shall be placed at the areas specified in the plans and details. Generally weed barrier is under cobble and wood mulch. Weed barrier fabric shall be anchored to the

ground with 6" U shaped staples. The staples shall be placed at a 4' spacing along all edges, overlaps, and throughout the area of weed barrier fabric. The weed barrier fabric shall be overlapped 4" between rolls.

- B. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees in Turf Areas: Apply organic mulch ring of 4-inch average thickness, with 5foot minimum diameter around trunks or stems or 12-inches outside dripline of evergreen trees. Do not place mulch within 3 inches of trunks or stems.
 - 2. Organic Mulch in Planting Areas: Apply 4-inch average thickness of organic mulch over whole surface of planting area. Finish level with adjacent finish grades.
 - a. Do not place mulch within 3 inches of trunks or stems.
 - 3. Rock Mulch in Planting Areas: Apply 3-inch average thickness of rock mulch over whole surface of planting area, but not less than required to fully conceal weed barrier. Finish level with adjacent finish grades.
 - a. Place organic mulch ring around each individual plant or shrub.
 - b. Do not place mulch within 3 inches of trunks or stems.
 - 4. Apply pre-emergent herbicide according to manufacturer's written instruction.
- C. Pathway gravel
 - 1. Compact the subgrade to a minimum of 95% of maximum dry density as per ASTM D698
 - 2. Install a minimum 4-inch layer of compacted base material (e.g., crushed stone or Class II Road Base).
 - 3. Spread the base material evenly and compact in 2-inch lifts using a plate compactor.
 - 4. Place the pathway gravel in 2-inch lifts, ensuring even distribution across the pathway.
 - 5. Compact each lift using a plate compactor to achieve a firm and stable surface before adding additional layers.
 - 6. Repeat until the gravel reaches the specified final depth (typically 3–4 inches). See details.
 - 7. Level the surface to ensure even grading and proper drainage as shown in the plans.
 - 8. Verify that the final surface elevation meets design specifications and transitions smoothly to adjacent surfaces.
 - 9. Lightly water the gravel surface during compaction to help bind fines and stabilize the pathway.
 - 10. Ensure the compacted gravel layer is firm, even, and meets the specified depth and slope tolerances.
 - 11. Adjust any areas that are low, uneven, or unstable before final acceptance.
- D. Cobble mulching
 - 1. Lay a geotextile or weed barrier fabric over the prepared subgrade to prevent weed growth.
 - 2. Overlap edges of the fabric by a minimum of 6 inches and secure it with landscape staples spaced 18–24 inches apart.
 - 3. Use natural river cobble or specified cobble material.
 - 4. Place cobble evenly over the prepared surface to the specified depth (typically 3–4 inches). See detail.
 - 5. Ensure cobbles are uniformly distributed, with minimal void spaces, to provide an even and visually consistent surface.
 - 6. Inspect the surface to confirm even coverage and appropriate depth across all areas.
 - 7. Adjust cobble placement to ensure consistent appearance and complete coverage of the weed barrier or base layer.
 - 8. Remove any debris, dirt, or excess materials from the cobble surface.

3.10 ESTABLISHMENT

- A. Provide maintenance during establishment period at no extra cost to Owner; Owner will pay for water.
- B. Maintain plant life for 30 days from date of Project Substantial Completion.

1. **During the establishment period the Contractor shall be on site a minimum of one hour per week throughout the maintenance period to monitor plants, water, adjust irrigation, and weed as necessary.**
 2. When maintenance period has not elapsed before the end of the growing season continue maintenance during the next growing season.
 3. Notify the Landscape Architect in writing upon termination of the required maintenance services. The Contractor shall continue maintenance services until written notification is provided.
- C. Irrigate sufficiently to saturate root system and prevent soil from drying out.
 - D. Remove dead or broken branches and treat pruned areas or other wounds.
 - E. Neatly trim plants where necessary.
 - F. Immediately remove clippings after trimming.
 - G. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions.
 - H. Control insect damage and disease. Apply pesticides in accordance with manufacturers instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
 - I. Remedy damage from use of herbicides and pesticides.
 - J. Replace mulch when deteriorated or displaced.
 - K. 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.

**SECTION 329410
LANDSCAPE EDGING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section specifies the furnishing and installation of Borcon steel landscape edging as manufactured by Border Concepts, Inc.

1.02 RELATED REQUIREMENTS

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's product information and installation instructions for Borcon steel edging.
- C. Samples: Two edging, 4 by 12 inches in size, indicating thickness and color.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for edging. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Border Concepts, Inc; Website: <https://www.borderconcepts.com/products/>.
- B. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

2.02 MATERIALS

- A. Steel Edging:
 - 1. Dimensions
 - a. Thickness: 3/16 inch (4.8 mm)
 - b. Height: 6 inches (152 mm)
 - c. Length: 10 feet (3.05 m) or 16 feet (4.88 m) sections
 - 2. Finish
 - a. Borcon weathering steel finish
 - 3. Anchor Stake Pockets
 - a. Stamped 32 inches (813 mm) on center.
- B. Anchoring Stakes:
 - 1. Material
 - a. Tapered steel
 - 2. Dimensions
 - a. 15 inches (381 mm) long, 3/16 inch (4.8 mm) thick
 - 3. Finish
 - a. Matching Borcon weathering steel finish

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: verify finished grades are suitable for installation.
- B. Notify the Architect of any conditions that may adversely affect installation.

3.02 PREPARATION

- A. Layout edging lines and grades according to project drawings.
- B. Excavate trenches to accommodate edging depth and anchoring stakes.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Install steel edging sections with anchor stake pockets facing the planting bed or as directed.
- C. Join sections using manufacturer's recommended methods to ensure continuous alignment.
- D. Cutting Steel Edging:
 - 1. Use a metal-cutting saw or other approved cutting tool to make clean, straight cuts.
 - 2. Deburr all edges after cutting to remove sharp edges and ensure safe handling.
 - 3. Coat exposed cut edges with a manufacturer-approved protective sealant or rust-preventative treatment to ensure long-term durability and uniform weathering.
- E. Curves and Radii
 - 1. Pre-form the steel edging to match required curves or radii before placing into position.
 - 2. For tight curves, use a bending tool designed for steel edging, or bend sections manually in small increments to avoid kinking or damaging the edging.
 - 3. Ensure that curves are smooth and consistent with the design intent.
- F. Drive anchoring stakes through stake pockets at 32-inch (813 mm) intervals or as specified.
- G. Ensure the top of the edging is flush with or slightly above the adjacent surface, as specified.
- H. Check alignment and levelness of edging sections after installation.
- I. Make necessary adjustments to ensure proper fit, consistent curves, and a neat appearance.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Inspect installed edging for alignment, stability, and finish quality.
- C. Replace or repair any damaged or defective edging sections.

3.05 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove excess materials and debris from the site upon completion.
- C. Wipe down steel edging to remove any dirt or residue from installation activities.
- D. Clean exposed surfaces of edging according to manufacturer's recommendations.

3.06 PROTECTION

- A. Protect installed edging from subsequent construction operations.

SECTION 33 0000

UTILITIES

PART 1 - GENERAL

1.1 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.2 SCOPE OF WORK

- A. The work includes, but is not necessarily limited to, the following:
 - 1. Domestic water piping system.
 - 2. Fire protection piping systems.
 - 3. Sewer piping system.
- B. Other items that may be specified or shown on the Drawings.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 5000, Temporary Facilities and Controls.
- B. Pertinent Sections specifying Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 01 8113, Sustainable Design Requirements.
- D. Section 31 0000, Earthwork.
- E. Section 31 2333, Trenching and Backfilling.

1.4 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
 - 1. Sun damaged or discolored PVC pipe will be rejected.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- C. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects or deficiencies discovered in their work during or following completion of the project. Correcting inadequate compaction is the sole responsibility of the contractor.

- D. Contractor shall be solely responsible for all subgrades built. Any repairs resulting from inadequate compaction or incorrect grades will be is the responsibility of the contractor.
- E. Per 2013 NFPA 13, with California amendments, provide Contractor's material and test certificate to the Owner, Architect, Project Inspector, Local Fire Authority and local water agency.

1.5 SUBMITTALS

- A. Refer to Section 01 3300.
- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.
- C. CAL-GREEN Submittals:
 - 1. Product Data – VOC Limits: For adhesives, sealants, fillers and primers, documentation including printed statement of VOC contents, comply with limits specified in Section 01 6116.
- D. Provide sieve analysis from accredited testing lab on pipe bedding material. Analysis shall have a current date not older than project contract signing date.
- E. Substitution: Provide all data of proposed material being submitted as a substitution. Provide comparison with specified product data and identify all differences. Failure to provide comparison will be reason for rejection.

1.6 FEES, PERMITS, AND UTILITY SERVICES

- A. Obtain and pay for permits and service charges required for installation of Work. Arrange for required inspections and secure written approvals from authorities having jurisdiction.
- B. Upon completion of work within right-of-way, provide copies of written final approval to the Architect.

1.7 GUARANTEE

- A. Refer to General Conditions and Section 01 3300.

1.8 REFERENCES AND STANDARDS

- A. California Green Building Standards Code, edition as noted on the drawings, as adopted by the California Division of the State Architect (DSA).
- B. ANSI/ASTM D698-00 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- C. ANSI/ASTM D1556-00 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- D. ANSI/ASTM D1557-02 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 Kg) Rammer and 18 inch (457 mm) Drop.

- E. ANSI/ASTM D 3017-05 Test Methods for Moisture Content of Soils and Soil-Aggregate Mixture by Nuclear Methods (Shallow Depth).
- F. ANSI/ASTM D 422-63 Test Method for Particle Size Analysis of Soil.
- G. ANSI/ASTM D 4318-05 Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit.
- H. CALTRANS Standard Specifications.
- I. CAL-OSHA, Title 8, Section 1590 (e).
- J. Any work within the street, highway or right-of-way shall be performed in accordance with the requirement of the governmental agencies having jurisdiction, and shall not begin until all of those governing authorities have been notified.
- K. NFPA 13, 24 and 25, latest editions.
- L. California State Health and Safety Code Section 116875, Lead Free Public Water Systems.
- M. California Plumbing Code, edition as noted on the drawings.
- N. Geologic Hazards and Geotechnical Engineering Report prepared by NV5.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.10 PROJECT CONDITIONS

- A. Existing civil, mechanical and electrical improvements are shown on respective site plans to the extent known. Should the Contractor encounter any deviation between actual conditions and those shown, he is to immediately notify the Architect before continuing work.

1.11 EXISTING SITE CONDITIONS

- A. Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.
- B. General Contractor to hold a pre-construction meeting, estimate 8 hours, for coordination of all underground utilities phasing and logistics with subcontractors.

1.12 PROTECTION

- A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and

below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.

- B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- D. Provide shoring, sheeting, sheet piles and or bracing to prevent caving, erosion or gulying of sides of excavation.
- E. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. The contractor shall make a reasonable effort on a daily basis to provide pumps and all equipment necessary to keep all excavations and the site free from water during entire progress of work, regardless of cause, source, or nature of water.
- F. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- G. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance. Dust control measures shall be in accordance with the local jurisdiction.
- H. Trees: Carefully protect existing trees that are to remain. Provide temporary irrigation as necessary to maintain health of trees.

1.13 SEASONAL LIMITS

- A. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by rains, fill operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.

1.14 RECORD DRAWINGS

- A. Keep a daily record of all pipe placed in ground, verified by Project Inspector.
- B. Upon completion of this Contract, furnish one tracing showing all outside utility lines, piping, etc., installed under this Contract. Locate and dimension all work with reference to permanent landmarks.
- C. All symbols and designations used in preparing "RECORD" drawings shall match those used in Contract drawings.
- D. Properly identify on as-builts and provide dimensions for all stubs for future connections. Provide concrete markers 6" dia. 12" deep, flush with finish grade at the ends of all stubbed pipes.
- E. Provide record drawing per Section 01 3300.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. VOC Limits for adhesives, sealants, fillers, coatings and primers. Comply with limits specified in related Section.
- B. Provide products conforming to local, State and Federal government requirements limiting the amount of volatile organic compounds contained in the product, for its intended application. If specified product exceeds current requirement, provide conforming product at no additional cost. Provide written confirmation to Architect describing reason for revision and demonstrate compliance of replacement product with specified requirements.

2.2 MATERIALS - GENERAL

- A. Provide each item listed herein or shown on drawings of quality noted or approved equal. All material shall be new, full weight, standard in all respects and in first-class condition. Insofar as possible, all materials used shall be of same brand or manufacture throughout for each class of material or equipment. Materials shall be of domestic manufacture and shall be tested within Continental United States.
- B. Grade or quality of materials desired is indicated by trade names or catalog numbers stated herein.
- C. Dimensions, sizes, and capacities shown are minimum and shall not be changed without permission of Architect.
- D. All materials in this section used for any public water system or domestic water for human consumption shall be lead free.
 - 1. For the purposes of this section, "lead free" means not more than 0.2 percent lead when used with respect to solder and flux and not more than 8 percent when used with respect to pipes and pipe fittings.
 - 2. All pipe, pipe or plumbing fitting or fixtures, solder, or flux shall be certified by an independent American National Standards Institute (ANSI) accredited third party, including, but not limited to, NSF International, as being in compliance with this section.
- E. All materials used for fire system piping shall be UL and FM approved.

2.3 VALVE BOXES

- A. Provide at each valve or cock installed in the ground, a Christy, Brooks, or equal to Christy G05CT, concrete valve box with cover marked for service. Domestic water shall be marked "Water" and fire supply shall be marked "Fire". Furnish extension handles for each size square nut valve, and provide "fork" handle for each size of "wheel handle" valve as required. Do not locate valve boxes in walk, or covered passages, curbs, or curb & gutters, unless necessary. If valve location is within concrete or asphalt paved surface, valve box shall be as detailed on plans for such condition. Provide valve box extensions as required to set bottom of valve box to bottom of piping in which valve is installed. Provide Owner with set of special wrenches and/or tools as required for operation of valves.

2.4 PIPES AND FITTINGS

- A. Sanitary Sewer: PVC Sewer Pipe shall be integral bell and spigot pipe conforming to ASTM D3034, with a maximum dimensional ratio (DR) of 35. Provisions must be made for contraction and expansion at each joint with a rubber ring gasket conforming to ASTM F477 and/or ASTM D3212.
1. Fittings and accessories shall be as manufactured and furnished by the pipe supplier, or approved equal, and have bell and/or spigot configurations compatible with that of the pipe.
- B. Domestic water Lines 3-1/2" and smaller:
1. Type K copper tubing: hard temper, with wrought copper fittings.
 2. Schedule 40 PVC: PVC pipe shall be polyvinyl chloride manufactured from clean, virgin materials in conformance with ASTM D1784, Class 12454. Pipe shall be SR (Schedule Rated) in accordance with ASTM D1785 for Schedule 40 pipe.
- C. Water lines 4" and larger:
1. PVC Pipe: PVC pipe shall be polyvinyl chloride manufactured from clean, virgin materials in conformance with ASTM D1784, Class 12454. Pipe shall have a maximum SDR of 18 for "Class 150" applications and a maximum SDR of 14 for "Class 200" applications. Pipe 4-inches and larger shall comply with AWWA Specification C900 and shall be of cast-iron-pipe-equivalent diameters. Pipe 4-inches and larger in diameter shall have solid cross-section rubber ring joints in accordance with ASTM F477. Fittings shall be PVC with the same pressure rating and hydrostatic test pressure as the pipe, or cast iron fittings with rubber gaskets sized for PVC pipe.
 2. Ductile Iron Pipe: Shall be Class 50 minimum ductile iron pipe conforming to AWWA Specification C151. Pipe shall be bell and spigot with "push-on" rubber gasket joints conforming to AWWA Specification C111, unless otherwise specified. Pipe shall be cement-mortar lined in conformance with AWWA Specification C104 and bituminous coated. Fittings shall be standard thickness and shall comply with AWWA Specification C110, and shall be cement-mortar lined and bituminous coated as specified above. Fittings shall be supplied with bell and/or spigot configurations compatible with that of the pipe.
- D. Solder: Lead Free. 95/5; 95% Tin / 5% Antimony.
- E. Ductile Iron Pipe Fittings: AWWA C110, C153, Ebba Iron, Mega-Lug, or equal.
- F. PVC Mechanical Fittings: Ebba Iron, Mega-Lug, or equal. All mechanical couplings shall have the longest standard sleeve length.
- G. Mechanical Fitting Bolts: Bolts and nuts shall be carbon steel with a minimum 60,000 psi tensile strength conforming to ASTM A 307, Grade A. Bolts shall be standard ANSI B1.1 Class 2A course threads. Nuts shall conform to ASTM A 563 and be standard ANSI B1.1, Class 2A course thread. All bolts and nuts shall be zinc coated.
- H. Fasteners Anti-Rust Coatings: After assembly, coat all fasteners with an Asphaltic Bituminous coatings conforming to 2007 NFPA 25, 10.3.5.2 and 10.8.3.5.

- I. Pipe Wrap: 8 mil polyethylene pipe wrap conforming to ANSI/AWWA C105/A21.5 standards.
- J. Locator Conductors shall be No. 12 direct burial insulated solid copper wire and shall be installed on all water pipes. The locator shall be attached to the top of the pipeline centerline. Locators shall be installed into each valve box with sufficient wire to reach the proposed finish grade.

2.5 SANITARY SEWER MANHOLES

- A. Shall be constructed as shown on plan details and per City of Chico requirements.

2.6 FLUSHING HOLES

- A. Flushing holes of same diameter as pipe up to 8" in size shall be installed in all horizontal soil and waste lines where indicated and at all points of change in direction. Flushing holes shall be located not less than 18" from building so as to provide sufficient space for rodding. No horizontal run over 100 feet shall be without flushing hole whether shown on drawings or not. Concrete collars shall be installed around the frames of all flushing holes.
- B. All flushing hole boxes shall be traffic rated with labeled lid, Christy G05CT or approved equal. Lid shall be vandal proof with stainless steel screws

2.7 UNIONS

- A. Furnish and install one union at each threaded or soldered connection to equipment and 2 unions, one on each side of valves on pipes 1/2" to 3".
- B. Locate unions so that piping can be easily disconnected for removal of equipment or valve. Provide type specified in following schedule:

Type of Pipe Union	
Steel Pipe:	150 lb. screwed malleable ground joint, brass, brass-to-iron seat, black or galvanized to match pipe.
Copper Tubing:	Brass ground joint with sweat connections.
PVC Sch 80 Pipe:	PVC union, FIPT X FIPT.

2.8 VALVES

- A. Provide valves as shown and other valves necessary to segregate branches or units. Furnish valves suitable for service intended. Valves shall be properly packed and lubricated. Valves shall be non-rising stem. Place unions adjacent to each threaded or sweat fitting valve. Install valves with bonnets vertical. All valves shall be lead free.
- B. Valves 1/2" thru 2": Shall be made of bronze, full size of pipe and lead free. Nibco S-113-FL Series; American G-300 Series; Matco 511 FL Series; Apollo 102T-FL Series, or approved equal. Brass valves of brass parts within valves will not be accepted.

- C. Valves 2 ½" thru 3": Shall be equal to the pressure rating of the connecting piping, but not less than Class 150; Shall be made of bronze, full size of pipe; Jenkins Fig. 2310 J; Lunkenheimer Fig. 2153; Crane Fig. 437; Stockham Fig. B-128, or approved equal.
- D. Valves 4" thru 12": Ductile Iron Resilient Wedge Gate Valves conforming to AWWA C509; Valves shall be rated for a minimum working pressure equal to the connecting piping, but not less than 150 psi, and shall have end fittings to conform to the pipe or fittings being connected. Valves shall be Waterous "Series 500", Mueller "Resilient Seat", Clow "Resilient Wedge", or approved equal. Valves shall open counter-clockwise and shall be furnished with two-inch square operating nuts when installed underground.

2.9 FIRE HYDRANTS

- A. Clow 960 Factory Painted per Local Jurisdiction Requirements, or approved equal, 36" bury, two 2-1/2" hose nozzles, one 4-1/2" pumper nozzle, intermediate section to serve as break-off flange with check valve. Hydrant shall conform to, and installation shall comply with the Local Jurisdiction.

2.10 POST INDICATOR

- A. Post Indicator shall be Mueller Co. A-20806 (adjustable) or approved equal.

2.11 BACKFLOW PREVENTERS

- A. Double Check Valve, Double Check Detector and Reduced Pressure Backflow Preventers:
 - 1. Backflow preventers shall be as required by the local agency and by the State of California's Department of Health Services most recent list of approved reduced pressure backflow preventers. All approved backflow preventers shall have ductile iron bodies.
 - a. Provide Backflow preventer blankets with locking device. Weatherguard R-30 insulated or equal.
 - b. Provide ball valve at all test ports with brass plug in valve.

2.12 TAPPING SLEEVE

- A. Shall be used on pipe sizes 6" thru 12" and shall be made with stainless steel material including stainless steel bolts. Flanges shall be ductile iron or high carbon steel. Gaskets shall seal full circumference of pipe. Shall be manufactured for operating pressure of 200 psi, and shall pass test pressure of 300 psi. Romac SST series; Smithblair 662; Mueller H304; Ford "FAST" tapping sleeve, or approved equal.

2.13 WATER METERS AND METER BOXES

- A. Water meters and meter boxes shall be as required by California Water Service Company standards.

2.14 SERVICE SADDLES

- A. Saddle body shall be made from ductile iron with epoxy coating or bronze. Cascade Style CSC-1; A.Y. McDonald model 3891 AWWA/3892 FNPT; Smith-Blair #317; Ford S70, S71, S90, (style B), or approved equal.

2.15 TRACER WIRE

- A. No. 10 THW solid copper wire shall be installed on all pipes. Solder all joints and splices and coat each soldered connection with a protective coating applied at the same thickness as the wires manufactured coating. The locator shall be attached to the top of the pipeline centerline. Locators shall be installed into each valve box with sufficient wire to reach the proposed finish grade.

PART 3 - EXECUTION

3.1 DRAWINGS AND COORDINATION

- A. General arrangement and location of piping, etc., are shown on Drawings or herein specified. Install work in accord therewith, except for minor changes that may be necessary on account of other work or existing conditions. Before excavation, carefully examine other work that may conflict with this work. Install this work in harmony with other craft and at proper time to avoid delay of work.
- B. Verify invert elevations at points of connection to existing systems prior to any excavation. If invert elevations differ from that shown on drawings, notify Architect immediately.
- C. In advance of construction, work out minor changes if conflicts occur with electrical or mechanical. Relocate services to suit actual conditions and work of other trades to avoid conflict therewith. Any adjustments or additional fittings to make adjustments shall not be cause for additional costs to the owner.
- D. Execute any work or apparatus shown on drawings and not mentioned in specifications, or vice versa. Omission from Drawings or Specifications of any minor details of construction, installation, materials, or essential specialties does not relieve Contractor of furnishing same in place complete.
- E. Graded pipes shall take precedence. If conflict should occur while placing the domestic water and fire service piping, the contractor shall provide any and all fittings necessary to route the water lines over or under such conflicting pipes at no additional costs to the owner.

3.2 ACCESS

- A. Continuously check for clearance and accessibility of equipment or materials specified herein to be placed. No allowance of any kind shall be made for negligence on part of Contractor to foresee means of installing his equipment or materials into proper position.

3.3 EXCAVATING AND BACKFILLING

- A. Excavation and Bedding:

1. General: Trench straight and true to line and grade with bottom smooth and free of irregularities or rock points. Trench width to be a minimum of 12" wider than outside diameter of pipe. Follow manufacturer's recommendations for use of each kind and type of pipe.
2. Bedding: Provide a bedding as noted on drawing details and per the Geotechnical Engineering Report for the full length of the pipe. Bedding shall have a minimum thickness beneath the pipe of 3" or 1/8 the outside diameter of the pipe, whichever is greater. Provide bell holes and depressions for pipe joints only of size required to properly make joint.
3. Preparation of the trench: The excavation and preparation of the trench shall be completed a sufficient distance in advance of the pipe laying to prevent dislodged material from entering the pipe.
4. See the project Geotechnical Engineering Report and Section 31 2333 for additional requirements.

B. Laying of Pipe:

1. General: Inspect pipe prior to placing. Sun damaged pipe will be rejected. Set aside any defective or damaged material. Do not place pipe in water nor place pipe when trenches or weather are unsuitable. Lay pipe bell up grade, true to line and grade.
 - a. Sewer pipe shall be laid in strict conformity to the prescribed line and grade, with grade bars set and each pipe length checked to the grade line. Three consecutive points on the same rate of slope shall be used at all times to detect any variation from a straight grade. In any case of discrepancy, work shall be stopped and the discrepancy immediately reported to the Owner's Representatives. In addition, when requested by the Owner's Representative, a string line shall be used in the bottom of the trench to insure a straight alignment of the sewer pipe between manholes. The maximum deviation from grade shall not be in excess of 1/4 inch. In returning the pipe to grade, no more than 1/4 inch depression shall result.
 - b. The Contractor shall expose the end of existing pipe to be extended, for verification of alignment and elevation, prior to trenching for any pipe which may be affected. All costs of such excavation and backfill shall be included in the price paid for the various items of work.
 - c. A temporary plug, mechanical type shall be installed on sewer pipe at the point of connection to existing facilities. If connecting to a public facility the plug shall conform to the requirements of the local jurisdiction. This plug shall remain in place until the completion of the balling and flushing operation.
2. Bell and Spigot Joints: Lubricate inside of bells and outside of spigots with soap solution. Wedge joints tight. Bell end of bell and spigot pipe to be pointed up grade. Assembly of pipe joints shall conform to manufacturer's requirements.

C. Backfilling:

1. General: Do not start backfill operations until required testing and inspection has been accomplished.
2. Compaction and Grading: Backfill around sides and to top of pipe as specified in the project Geotechnical Engineering Report and Section 31 2333.

3. If trenching in area previously lime or cement treated backfill top of trench section, same depth as lime or cement treatment with Class 2 Aggregate Base compacted to 95% minimum relative compaction.

3.4 INSTALLATION OF WATER PIPING

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.
- D. All pipe shall be laid on a smooth bed, prepared in accordance with the provisions specified in Section 31 2333. As soon as possible after the installation of the pipe, sufficient backfill material shall be placed on the pipe to protect it from temperature changes. The ends of the pipeline shall be closed with watertight caps or plugs at all times, except when laying pipe. The Contractor shall take all necessary precautions to prevent contaminated water, oil, grease, dirt, rodents, or other contaminants from entering the pipeline
- E. Immediately cap or plug ends of, and opening in, pipe and fittings to exclude dirt until final connections made. Use reducing fittings where any change in pipe size occurs. Bushings shall not be used.
- F. General: Should existing conditions or other work prevent the running of pipes or the setting of equipment at the points indicated by drawings, changes as authorized by the Architect shall be made without additional cost to the Owner.
- G. All bolts used on mechanical fittings shall be thoroughly coated with an asphaltic bituminous coating conforming to latest edition NFPA 24.
- H. All buried metal shall be incased with 8 mil polyethylene wrap so that no soil is in contact with metal.
- I. Anchorage: Concrete thrust blocks shall be provided in accordance with the Standard Details included in the Plans. Size of thrust blocks shall be approved by the Owner's Representative. Concrete shall be carefully placed against the valve or fitting to avoid covering or obstructing bolts or connectors at the valve or fitting joints. Concrete for Thrust Restraints shall be Class C concrete and shall conform to the applicable portions of Sections 51 and 90 of the State Standard Specifications.
- J. Sewer Lateral Crossings: Crossings of sewer service laterals shall be made above the sewer lateral wherever possible. Depth of cover over the water main may be reduced to 30 inches where such reduction is necessary to allow crossing above sewer service laterals. If it is necessary to cross below sewer service laterals, the water main shall be installed with at least 12 inches of vertical separation from the sewer lateral and no joints in the water main shall be placed within ten feet, horizontally, of the sewer service lateral.

3.5 INSTALLATION OF SEWER MANHOLES

- A. Form bottom of excavation clean and smooth to correct elevation. The subgrade shall be carefully prepared to provide a firm support and prevent future settlement.

- B. Form and place cast-in-place concrete base pad or place precast concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.
- E. Offsite Work: All work beyond the property lines shall be done in strict conformance with the requirements of the governmental agencies having jurisdiction.
- F. Cutting and Patching: Remove and replace existing surface features per applicable specification section where pipe is installed in areas of existing improvements.

3.6 INSTALLATION OF SEWER FLUSHING HOLES

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Establish elevations and pipe inverts for inlets and outlets as indicated.
- C. Mount lid and frame level in grout.
- D. Offsite Work: All work beyond the property lines shall be done in strict conformance with the requirements of the governmental agencies having jurisdiction.
- E. Cutting and Patching: Remove and replace existing surface features per applicable specification section where pipe is installed in areas of existing improvements.

3.7 DEWATERING

- A. Contractor to provide trench dewatering as necessary, no matter what the source is, at no additional cost to the owner.

3.8 CLOSING IN OF UNINSPECTED WORK

- A. Do not allow or cause work installed to be covered up or enclosed before it has been inspected, tested, and approved. Should work be enclosed or covered up before it has been approved, uncover work at own expense. After it has been inspected, tested and approved, make repairs necessary to restore work of other contractors to condition in which it was found at time of cutting.

3.9 CARE AND CLEANING

- A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in new condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures and trim that are installed as part of this work. Leave systems and equipment in satisfactory new operating condition.
- B. Drain and flush piping to remove grease and foreign matter.
- C. Sewer piping shall be balled and flushed.

- D. Clean out and remove surplus materials and debris resulting from the work, including surplus excavated material.
- E. Flush fire service piping 3 times in the presence of the project inspector. Each flushing shall be 3 minutes minimum.

3.10 SEWER INTERNAL INSPECTIONS AND TESTING

- A. Upon completion of construction and prior to final inspection, the Contractor shall clean the entire new pipeline of all dirt and debris. Any dirt or debris in previously existing pipes or ditches in the area, which resulted from the new installation, shall also be removed.
 - 1. Pipe Cleaning: Pipes shall be cleaned by the controlled balling and flushing method. Temporary plugs shall be installed and maintained during cleaning operations at points of connection to existing facilities to prevent water, dirt, and debris from entering the existing facility.
 - 2. Deflection Testing: If flexible pipe material is used, the pipe installation shall be tested for excessive deflection after all backfill and resurfacing materials have been placed and the line has been cleaned. A mandrel having an outside diameter of 95% of the average manufactured internal diameter shall be pulled through the pipeline. If the mandrel does not pass freely through the pipe, the pipe shall be re-excavated, bedded and backfilled to adequately support the pipe and reduce the pipe deflection to 5% of less. The pipeline shall then be flushed again by means of the ball and flushing method, and re-tested for deflection.
 - 3. Leakage Testing: The Contractor shall test all sanitary sewers, including service connections, for leakage by air testing in accordance with the following steps and ASTM F1417. In the event of conflict, the requirements of ASTM F1417 take precedence. The Contractor shall furnish all labor, tools, materials, and equipment required to perform the tests. Air testing shall be done after trench backfilling and immediately following deflection testing.

Conduct an air test between each two consecutive manholes by plugging each end of the section to be tested and all pipe outlets in the section with suitable test plugs. One plug used at a manhole shall have an inlet tap or other provision for connecting an air hose from the air supply equipment. The equipment shall include valves to control the rate at which air flows into the test section and pressure gages with minimum graduations of 0.1 psi and an accuracy of ± 0.04 psi to monitor the air pressure within the test section.

Apply air pressure slowly to the test section until the pressure reaches 4.0 psi, plus an adjustment of 0.433 psi for each foot of ground water above the pipe crown in the line being tested. Internal air pressure, including adjustment for ground water, should never exceed 5.0 psi. When the pressure reaches 4.0 psi, plus adjustment for ground water, throttle the air supply so that the internal pressure is maintained between 4.0 and 3.5 psi for at least 2 minutes to permit temperature stabilization. When the pressure has stabilized at 3.5 psi or above, disconnect the air supply, start a stopwatch, and allow the stopwatch to run until the pressure has dropped 1.0 psi.

The permissible time allocated for the 1.0 psi pressure drop on the basis of the pipe diameter and the length of pipe being tested shall be based on ASTM F1417. The air test for a section of pipe shall be considered acceptable if the time elapsed for the 1.0 psi pressure drop is equal to or greater than the time indicated in ASTM F1417. Sections of

pipe that are not considered acceptable shall be repaired or replaced and retested at no cost to the Owner.

3.11 WATER LINE TESTING

- A. All parts of the entire pipeline installation shall be tested at a minimum pressure of 125 PSI. Tests shall be made in the presence of the Owner’s Representative.
- B. Before the test, the pipeline shall be sufficiently anchored to withstand the test pressure. During the filling of the line with water, precautions shall be taken to prevent air pockets at high points. Water may be allowed to stand in the line for several hours prior to the test. The total test time including initial pressurization, initial expansion, and time at test pressure, must not exceed 8 hours. If the pressure test is not completed due to leakage, equipment failure, etc., the test section should be de-pressurized, and allowed to “relax” for at least 8 hours before bringing the test section up to test pressure again. During the test the leakage shall not exceed 5 gallons per 24 hours per thousand feet of pipe per inch of nominal diameter. Test sections shall be as short as valve configurations permit. If any valved section of pipe shows greater leakage than specified, the Contractor shall locate and repair the leaks and shall retest that section of line at no additional cost to the Owner.

<u>Test Schedule</u>	
System Tested	Test Pressure PSIG Tested With
Public Water Mains:	Per local jurisdiction requirements.
Private Domestic Water Piping:	125 Lbs. Water 4 hrs.
Fire Protection Piping:	200 Lbs. Water pressure, 4 hrs duration with no pressure loss.

- C. Testing equipment, materials, and labor shall be furnished by contractor.

3.12 WATER SYSTEM STERILIZATION

- A. Public Water Mains: Shall be flushed and disinfected per the local jurisdiction requirements
- B. Clean and disinfect all site water systems connected to the domestic water systems in accordance with AWWA Standard C651 and as required by the local Building and Health Department Codes, and EPA.
 - 1. Clean and disinfect industrial water system in addition to the domestic water system as directed by the local jurisdiction.
 - 2. Disinfect existing piping systems as required to provide continuous disinfection upstream to existing valves. Isolation of the new water system from the existing water system shall be done per the local jurisdiction requirements.
- C. Domestic water sterilization shall be performed by a licensed “qualified applicator” as required by CAL-EPA Pesticide Enforcement Branch for disinfecting and sterilizing drinking water.

- D. Disinfecting Agent: Chlorine product that is a registered product with Cal-EPA for use in California potable water lines, such as Bacticide, CAL-EPA Registration No. 37982-20001.
- E. Contractor to provide a 1” service valve connected to the system at a point within 2’-0” of its junction with the water supply line. After sterilization is complete Contractor to provide cap at valve.
- F. Sterilization Procedure to be as follows:
 - 1. Flush pipe system by opening all outlets and letting water flow through the system until clear water flows from all outlets.
 - 2. Inject disinfecting agent to provide a minimum chlorine residual concentration of at least 50 parts per million (ppm) of free chlorine at each outlet.
 - 3. Provide sign at all outlets which reads “Water Sterilization in Progress – Do not operate”. Remove signs at conclusion of test.
 - 4. Close all outlets and valves, including valve connecting to water supply line and 1” service valve. Retain treated water in pipe for a minimum of twenty-four hours. Should chlorine residual at pipe extremities be less than 10 PPM at this time, pipe shall be re-chlorinated.
 - 5. After chlorination, flush lines of chlorinated water and refill from domestic supply. Continue flushing until residual chlorine is less than or equal to 0.2 ppm, or a residual the same as that of the test water.
- G. Chemical and bacteriological tests shall be conducted by a state-certified laboratory and approved by the local authorities having jurisdiction.
- H. Submit written report to Health Department as required by State Regulations. Provide a copy of report to Architect prior to completion of project.
- I. The costs of sterilization and laboratory testing shall be paid for by the contractor.
- J. All sterilizing and testing shall conform with AWWA and local jurisdiction requirements.

3.13 CLEANING

- A. Upon completion of work of this Section promptly remove from the working area all scraps, debris and surplus material of this Section.

- END OF SECTION -

SECTION 33 4000
STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 INCLUSION OF OTHER CONTRACT DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 1 are fully applicable to this Section, as if repeated herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 5000, Temporary Facilities and Controls.
- B. Pertinent Sections specifying Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 01 8113, Sustainable Design Requirements.
- D. Section 31 2333, Trenching and Backfilling.
- E. Section 32 1200, Asphalt Concrete Paving.

1.3 QUALITY ASSURANCE

- A. Use only new materials and products, unless existing materials or products are specifically shown otherwise on the Drawings to be salvaged and re-used.
- B. All materials, components, assemblies, workmanship and installation are to be observed by the Owner's Inspector of Record. Work not so inspected is subject to uncovering and replacement.
- C. The representatives of the Owner's testing lab will not act as supervisor of construction, nor will they direct construction operations. Neither the presence of the Owner's testing lab representatives nor the testing by the Owner's testing lab shall excuse the contractors or subcontractors for defects discovered in their work during or following completion of the project. Correcting inadequate compaction is the sole responsibility of the contractor.
- D. Contractor shall be solely responsible for all subgrades built. Any repairs resulting from inadequate compaction is the responsibility of the contractor.

1.4 SUBMITTALS

- A. Refer to Section 01 3300.
- B. Manufacturer's Data: Submit list and complete descriptive data of all products proposed for use. Include manufacturer's specifications, published warranty or guarantee, installation instructions, and maintenance instructions.

C. CAL-GREEN Submittals:

1. Product Data – VOC Limits: For adhesives, sealants, fillers and primers, documentation including printed statement of VOC contents, comply with limits specified in Section 01 6116.

1.5 GUARANTEE

- A. Refer to General Conditions and Section 01 3300.

1.6 REFERENCES AND STANDARDS

- A. California Green Building Standards Code, edition as noted on the drawings, as adopted by the California Division of the State Architect (DSA).
- B. ANSI/ASTM D698-00 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- C. ANSI/ASTM D1556-00 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- D. ANSI/ASTM D1557-02 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- E. ANSI/ASTM D 3017-05 Test Methods for Moisture Content of Soils and Soil-Aggregate Mixture by Nuclear Methods (Shallow Depth).
- F. ANSI/ASTM D 422-63 Test Method for Particle Size Analysis of Soil.
- G. ANSI/ASTM D 4318-05 Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit.
- H. CALTRANS Standard Specifications.
- I. CAL-OSHA, Title 8, Section 1590 (e).
- J. Any work within the street, highway or right-of-way shall be performed in accordance with the requirement of the governmental agencies having jurisdiction, and shall not begin until all of those governing authorities have been notified.
- K. California Plumbing Code, edition as noted on the drawings.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle in strict accord with the local jurisdiction.
- B. Make delivery to job when notified by Contractor verifying that the job is ready to receive the work of this Section and that arrangements have been made to properly store, handle and protect such materials and work.

1.8 PROJECT CONDITIONS

- A. Existing civil, mechanical and electrical improvements are shown on respective site plans to the extent known. Should the Contractor encounter any deviation between actual conditions and those shown, he is to immediately notify the Architect before continuing work.

1.9 EXISTING SITE CONDITIONS

- A. Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make Contractor liable for damage to these utilities arising from Contractor's operations subsequent to discovery of such unknown active utilities.

1.10 PROTECTION

- A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.
- B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- D. Provide shoring, sheeting, sheet piles and/or bracing to prevent caving, erosion or gulying of sides of excavation.
- E. Surface Drainage: Provide for surface drainage during period of construction in manner to avoid creating nuisance to adjacent areas. The contractor shall make a reasonable effort on a daily basis to keep all excavations and the site free from water during entire progress of work, regardless of cause, source, or nature of water.
- F. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- G. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance. Dust control measures shall be in accordance with the local jurisdiction.
- H. Trees: Carefully protect existing trees that are to remain.

1.11 SEASONAL LIMITS

- A. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by rains, fill operations shall not be resumed until field tests indicate that moisture content and density of fill are satisfactory.

1.12 TESTING

- A. General: Refer to Section 01 4523 – TESTING AND INSPECTION SERVICES AND STRUCTURAL TESTS AND INSPECTIONS LIST, DSA-103.
- B. Geotechnical Engineer: Owner is retaining a Geotechnical Engineer to determine compliance of fill with Specifications, and to direct adjustments in fill operations. Costs of Geotechnical Engineer will be borne by Owner; except those costs incurred for re-tests or re-inspection will be paid by Owner and backcharged to Contractor.

1.13 RECORD DRAWINGS

- A. Keep a daily record of all pipe placed in ground, verified by Project Inspector.
- B. Upon completion of this Contract, furnish one tracing showing all outside utility lines, piping, etc., installed under this Contract. Locate and dimension all work with reference to permanent landmarks.
- C. All symbols and designations used in preparing "RECORD" drawings shall match those used in Contract drawings.
- D. Properly identify all stubs for future connections, as to location and use, by setting of concrete marker at finished grade in the manner suitable to Architect.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. VOC Limits for adhesives, sealants, fillers, coatings and primers. Comply with limits specified in related Section.
- B. Provide products conforming to local, State and Federal government requirements limiting the amount of volatile organic compounds contained in the product, for its intended application. If specified product exceeds current requirement, provide conforming product at no additional cost. Provide written confirmation to Architect describing reason for revision and demonstrate compliance of replacement product with specified requirements.

2.2 MATERIALS

- A. Pipe: Use one or more of the following, unless noted on the Drawings otherwise. EXCEPTIONS: PVC Pipe may only be used up to and including 24" diameter, unless specifically noted on Drawings

1. Reinforced Concrete Pipe (RCP): Conform to ASTM C76 Class III with rubber gasket joints conforming to ASTM C443.
 2. Cast Iron Pipe (CIP): No hub service weight cast iron with neoprene sleeve and stainless steel band couplings and conforming to CISPI Standard 301.
 3. Polyvinyl Chloride Pipe (PVC): SDR35 conforming to ASTM D3034 with elastomeric joints conforming to ASTM D3212 for pipe to 15", SDR 51 conforming to ASTM F679 for pipe 18" to 27".
 4. High Density Polyethylene Pipe: The pipe shall have a smooth interior and annular exterior corrugations. 4" to 60" diameter shall conform to ASTM F2648. Pipe shall be joined using a bell and spigot joint meeting ASTM F2648. Joints shall be soil-tight sleeves with gaskets conforming to ASTM F477. Fittings shall conform to ASTM F2306 and shall have bell and spigot connections utilizing a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of ASTM F2306.
- B. Perforated Pipe (for subdrains): Shall be ADS N12 pipe, 3 hole, ASTM F 405, AASHTO M 252; PCV ASTM D3034 SDR-35 storm drain pipe
- C. Manhole: Shall be as shown on the drawing details.
- D. Drop Inlet: Shall be as shown on the drawing details.
- E. Catch basin: Shall be as shown on the drawing details.
- F. Mortar: For pipe connections to concrete drainage structures, conform to ASTM C270 type N mortar. Place within one half hour after adding water.
- G. Crushed Rock: Imported washed crushed rock. Minimum 100% passing 3/4 inch sieve.
- H. Permeable Material: Shall be Caltrans permeable material Class 1, Type B per Section 68-2.02F(2) of the State Standard Specifications.
- I. Trench drain: Polycast, Polydrain or equal and as shown on drawings.
- J. Area Drains: Shall be as shown on the drawing details.
- K. Floor Drains: Shall be as shown on the drawing details.
- L. Flushing holes: Shall be as shown on the drawing details.
- M. Planter drains: Shall be as shown on the drawing details.
- N. Geotextile Filter Fabric: minimum 6 ounce per square yard, non-woven geotextile filter fabric such as Amoco 4506 manufactured by Amoco Fabrics and Fibers Company or equal.
- O. Geotextile Fabric (at storm drain leach trenches): Shall be Class A conforming to the requirements of Section 96-1.02B of the State Standard Specifications.

PART 3 - EXECUTION

3.1 INSPECTION LAYOUT AND PREPARATION

- A. Prior to installation of the work of this Section, carefully inspect and verify by field measurements that installed work of all other trades is complete to the point where this installation may properly commence.
- B. Layout all work, establish grades, locate existing underground utilities, set markers and stakes, setup and maintain barricades and protection facilities; all prior to beginning actual earthwork operations. Layout and staking shall be done by a licensed Land Surveyor or Professional Civil Engineer.
- C. Verify that specified items may be installed in accordance with the approved design.
- D. In event of discrepancy, immediately notify Owner and the Architect. Do not proceed in discrepant areas until discrepancies have been fully resolved.

3.2 INSTALLATION

- A. General: Installation shall be in strict conformance with referenced standards, the manufacturer's written directions, as shown on the drawings and as herein specified.
- B. Verify invert elevations at points of connection to existing systems prior to any excavation. If invert elevations differ from that shown on drawings, notify Architect immediately.
- C. Excavation and Bedding:
 - 1. General: Trench straight and true to line and grade with bottom smooth and free of irregularities or rock points. Trench width in accordance with pipe manufacturer's recommendations and as per the drawings. Follow manufacturer's recommendations for use of each kind and type of pipe.
 - 2. Bedding: Provide bedding as detailed on plans for the full length of the pipe. Bedding shall have a minimum thickness beneath the pipe of 3" or 1/8 the outside diameter of the pipe, whichever is greater. Provide bell holes and depressions for pipe joints only of size required to properly make joint. Pipe bedding material and placement shall conform with the project Geotechnical Engineering Report.
- D. Laying of Pipe:
 - 1. General: Inspect pipe prior to placing. Set aside any defective or damaged material. Do not place pipe in water nor place pipe when trenches or weather are unsuitable. Lay pipe upgrade, true to line and grade. Grade of pipe shall be established by using invert elevations and slopes shown on plans. The slopes shown on the plans have been rounded to the nearest tenth or hundredth of a percent as shown on the plans. Maximum variation from true slope of 1/8 inch in 10 feet.
 - 2. Bell and Spigot Joints: Lubricate inside of bells and outside of spigots with soap solution or as recommended by manufacture. Wedge joints tight. Bell of bell and spigot pipe to be pointed upgrade.

3. Pipe shall be bedded uniformly throughout its length.
4. Pipe elevation shall be within 0.02 feet of design elevation as shown on plans.
5. Off Site Work: All work beyond the property lines shall be done in strict conformance with the requirements of the governing agency.

E. Backfilling:

1. General: Do not start backfill operations until required testing has been accomplished.
2. Trenches and Excavations: Backfill with material as detailed on plans, as specified in the project Geotechnical Engineering Report, and as specified in Section 31 2333.

F. Grouting of Pipes: Grout pipes smooth and water tight at drop inlet, manholes, and curb inlets. Grout back side of hood at curb inlets all grouting shall be smooth and consistent.

G. Off Site Work: All work beyond the property lines shall be done in strict conformance with the requirements of the local agency.

H. Cutting and Patching: Remove and replace existing surface features per applicable specification section (i.e. asphaltic concrete or concrete paving) where pipe is installed in areas of existing improvements.

I. Manholes:

1. Form bottom of excavation clean and smooth to correct elevation. The subgrade shall be carefully prepared to provide a firm support and prevent future settlement.
2. Form and place cast-in-place concrete base pad or place precast concrete base pad, with provision for pipe end sections.
3. Establish elevations and pipe inverts for inlets and outlets as indicated.
4. Mount lid and frame level in grout, secured to top cone section to elevation indicated.
5. Off Site Work: All work beyond the property lines shall be done in strict conformance with the requirements of the governmental agencies having jurisdiction.

3.3 TOLERANCES

A. Storm Drain structure grates:

1. In landscape and lawn areas $\pm 0.05'$.
2. In sidewalk and asphalt pavement $\pm 0.025'$.
3. In curb and gutter application $\pm 0.0125'$.

B. Flushing Hole Lids:

1. In landscape areas; 0.10 higher than surrounding finish grade, $\pm 0.05'$.
2. In sidewalks and asphalt pavement; Flush with surrounding finish grade, $\pm 0.02'$.

3.4 DEWATERING

- A. Contractor to provide trench dewatering as necessary, no matter what the source is, at no additional cost to the owner.

3.5 FLUSHING

- A. The Contractor shall thoroughly ball and flush the storm drain system to remove all dirt and debris. Discharge water to an approved location.

3.6 CLEANING

- A. Upon completion of work of this Section promptly remove from the working area all scraps, debris and surplus material of this Section.
- B. Prior to final acceptance, the Contractor shall flush and clean all parts of the completed storm drain. The storm drain shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, as directed by the Owner's Representative.

- END OF SECTION -