

PROJECT MANUAL



General Brown Central School District

Jr./Sr. High School Renovations and Reconstruction Project Phase 1A & B

17643 Cemetery Road, Dexter, New York 13634

BCA Project No. 2023-105

SED Control No. 22-04-01-04-0-001-010 Jr./Sr. High School
22-04-01-04-0-001-011 Jr./Sr. High School
22-04-01-04-7-016-001 Softball Dugout (1st)
22-04-01-04-7-017-001 Softball Dugout (3rd)

**Bernier, Carr & Associates, Engineers,
Architects and Land Surveyors, P.C.**

15 Public Square
Watertown, New York 13601
(315) 782-8130



Set # _____

VOLUME III OF III
BIDDING DOCUMENTS AND TECHNICAL SPECIFICATIONS
DIVISIONS 22, 23, 26 – 28, 31 – 33

The above signed Architect/Engineer certifies that, to the best of his knowledge, information and belief, the plans and specifications are in accordance with applicable requirements of the New York State Uniform Fire Prevention and Building Code, the State Energy Conservation Code, construction standards of the State Education Department, and Part 56 of Title 12 of the Official Compilation of Codes, Rules and Regulations of the State of New York.

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**SECTION 22 0510
BASIC PLUMBING REQUIREMENTS**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, tools, materials, accessories, parts, transportation, taxes, and related items, essential for installation of the work and necessary to make work, complete, and operational. Provide new equipment and material unless otherwise called for. References to codes, specifications and standards called for in the specification sections and on the drawings mean, the latest edition, amendment and revision of such referenced standard in effect on the date of these contract documents.

1.02 LICENSING

- A. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
- B. Plumbing work shall be performed by, or under, the direct supervision of a licensed master plumber if so required by the local jurisdiction.
- C. The Contractor shall be responsible for reviewing the local jurisdiction requirements prior to bidding.

1.03 PERMITS

- A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges.

1.04 CODE COMPLIANCE

- A. Provide work in compliance with the following:
 - 1. The Building Code of New York State including The Fire Code; Property Maintenance Code; Plumbing Code, Mechanical Code and Fuel Gas Code; and The Energy Code of New York.
 - 2. New York State Department of Labor Rules and Regulations.
 - 3. Occupational Safety and Health Administration (OSHA).
 - 4. National Electrical Code, NFPA 70.
 - 5. Local Codes and Ordinances.
 - 6. Life Safety Codes, NFPA 101 (2000).
 - 7. New York Board of Fire Underwriters.
 - 8. FGI Healthcare Guidelines.

1.05 GLOSSARY

- A. AIA - American Institute of Architects
- B. ANSI - American National Standards Institute
- C. ASHRAE - American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.
- D. ASME - American Society of Mechanical Engineers
- E. ASPE - American Society of Plumbing Engineers
- F. ASTM - American Society for Testing Materials
- G. NYBFU - New York Board of Fire Underwriters
- H. NEC - National Electrical Code
- I. NEMA - National Electrical Manufacturer's Association
- J. NESC - National Electrical Safety Code
- K. NFPA - National Fire Protection Association
- L. UFPO - Underground Facilities Protective Organization
- M. UL - Underwriter's Laboratories, Inc.
- N. OSHA - Occupational Safety and Health Administration
- O. NYS/UFPBC - New York State Uniform Fire Prevention and Building Code

1.06 DEFINITIONS

- A. Acceptance - Owner acceptance of the project from Contractor upon certification by Owner's Representative.
- B. Approval/Approved - Written permission to use a material or system.
- C. As Called For - Materials, equipment including the execution specified/shown in the contract documents.
- D. Code Requirements - Minimum requirements.
- E. Concealed - Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
- F. Exposed - Work not identified as concealed.
- G. Equal or Equivalent - Equally acceptable as determined by Owner's Representative.
- H. Furnish - Supply and deliver to installed location.
- I. Furnished by Others - Receive delivery at job site or where called for and install.
- J. Inspection - Visual observations by Owner's site Representative.
- K. Install - Mount and connect equipment and associated materials ready for use.
- L. Labeled - Refers to classification by a standards agency.
- M. Make - Refers to the article, Equipment Arrangements, and the article, Substitutions.
- N. Or Approved Equal - Approved equal or equivalent as determined by Owner's Representative.
- O. Provide - Furnish, install, and connect ready for use.
- P. Relocate - Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
- Q. Replace - Remove and provide new item.
- R. Review - A general contractual conformance check of specified products.
- S. Roughing - Pipe, duct, conduit, equipment layout and installation.
- T. Satisfactory - As specified in contract documents.

1.07 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed.
Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time.
Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for: confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

1.08 PROTECTION OF PERSONS AND PROPERTY

- A. Contractor shall assume responsibility for construction safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature required to provide safe conditions for all workmen and site visitors.

1.09 EQUIPMENT ARRANGEMENTS

- A. The contract documents are prepared on basis of one manufacturer as “design equipment,” even though other manufacturer’s names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than “design equipment,” submit detailed drawings, indicating proposed installation of equipment. Show maintenance arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger motors, feeders, breakers, and equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings, or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified “design equipment” item which conforms to contract documents.

1.10 CONTINUITY OF SERVICES

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to “General Conditions of the Contract for Construction” for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner’s Representative. Provide, as part of contract, temporary mechanical and plumbing connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical/plumbing facilities or services.

1.11 ROUGHING

- A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, interferences, etc. Make necessary changes in contract work, equipment locations, etc., as part of a contract to accommodate work to obstacles and interferences encountered. Before installing, verify exact location and elevations at work site. DO NOT SCALE plans. If field conditions, details, changes in equipment or shop drawing information require an important rearrangement, report same to Owner’s Representative for review. Obtain written approval for all major changes before installing.
- B. Install work so that items both existing and new are operable and serviceable. Eliminate interference with removal of coils, motors, filters, belt guards and/or operation of doors. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Where Contractor could not reasonably be expected to find such trade interferences due to concealment in walls, ceiling or floors, such relocations will be done by Change Order, if not, included in contract work. Contractor shall relocate existing work in way of new construction. Provide new materials, including new piping and insulation for relocated work.
- C. Coordinate work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner’s Representative exact location of all equipment in finished areas, such as thermostat, fixture, and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and plumbing drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, speakers, and other items. Do not rough-in contract work without reflected ceiling location plans.

1.12 REMOVAL WORK

- A. Where existing equipment removals are called for, submit complete list to Owner's Representative all items that Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State, and Local law requirements. Where equipment is called for to be relocated, contractor shall carefully remove, clean and recondition, then reinstall. Removal all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl space, and roof to determine the total Scope of Work. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

1.13 EQUIPMENT AND MATERIAL INSTALLATION

- A. Provide materials that meet the following minimum requirements:
1. Materials shall have a flame spread rating of 25 or less and smoke developed rating of 50 or less, in accordance with NFPA 255.
 2. All equipment and material for which there is a listing service shall bear a UL label.
 3. Potable water systems and equipment shall be built according to AWWA Standards.
 4. Electrical equipment and systems shall meet UL Standards and requirements of the NEC.

1.14 CUTTING AND PATCHING

- A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch any cut or abandoned holes left by removals of equipment, fixtures, etc. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

1.15 PAINTING

- A. Include painting for patchwork with color to match adjacent surfaces. Where color cannot be adequately matched, paint entire surface. Provide one (1) coat of primer and two (2) finish coats or as called for in the Mechanical and Electrical Specifications. Refer to General Construction Specifications for additional information.

1.16 CONCEALMENT

- A. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

1.17 CHASES

- A. New Construction:
1. Certain chases, recessed, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical and Electrical Trades work shall provide all other openings required for their contract work.
 2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction work.
 3. Assume responsibility for correct and final location and size of such openings.
 4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.

5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2" above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all work and equipment damaged during course of drilling. Firestop all unused sleeves.
 6. Provide angle iron frame where openings are required for contract work, unless provided by General Construction Contractor.
- B. In Existing Buildings:
1. Drill holes for floor and/or roof slab openings.
 2. Multiple pipes smaller than 1" properly spaced and supported may pass through one 6" or smaller diameter opening.
 3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2" above floors.
 4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

1.18 FLASHING, SEALING, FIRE-STOPPING

- A. See Specification Section 22 0515 - Plumbing Firestopping.

1.19 SUPPORTS

- A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support mechanical/electrical work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

1.20 PLUMBING EQUIPMENT CONNECTIONS

- A. Contractor is responsible for draining, filling, venting, chemically treating and restarting any systems which are affected by work shown on the Contract Documents unless specifically noted otherwise.
- B. Provide roughing and final water, waste, vent, propane, etc. connections to all equipment. Provide loose key stops, sanitary "P" traps, tailpiece, adapters, gas cocks, and all necessary piping and fittings from roughing point to equipment. Provide installation of sinks, faucets, traps, tailpiece furnished by others. Provide continuation of piping and connection to equipment that is furnished by others. Provide relief valve discharge piping from equipment relief valves to point(s) of safe discharge.
- C. Provide as part of plumbing work valved water outlet adjacent to equipment requiring same. Provide equipment type floor drains, or drain hubs, adjacent to equipment.
- D. Install controls and devices furnished by others.
- E. Refer to Contract Documents for roughing schedules, and equipment lists indicating scope of connections required.
- F. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, wiring as required.

1.21 STORAGE AND PROTECTION OF MATERIALS

- A. Store materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
- B. Refer to "General Conditions of the Contract for Construction."

1.22 FREEZING AND WATER DAMAGE

- A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no charge in contract, any such damage to equipment, systems, and building. Perform first seasons winterizing in presence of Owner's operating staff.

1.23 LUBRICATION CHART

- A. Provide lubrication chart, 8 ½" x 11" minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall in area of equipment. List all motors and equipment in contract. Obtain and list necessary information by name/location of equipment, manufacturer recommended types of lubrication and schedule. Lubricate motors as soon as installed and perform lubrication maintenance until final acceptance. Plumbing trade shall add contract items to the chart provided by the Heating trade or provide separate charts.

1.24 OWNER INSTRUCTIONS

- A. Before final acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct designated person on proper operation, and care of systems/equipment. Repeat instructions, if necessary. Obtain written acknowledgement from person instructed prior to final payment. Contractor is fully responsible for system until final acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. List under clear plastic, operating, maintenance, and starting precautions procedures to be followed by Owner for operating systems and equipment.

1.25 MAINTENANCE MANUALS

- A. Prepare Instructions and Maintenance Portfolios. Include one copy of each of approved Shop Drawings, wiring diagrams, piping diagrams spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, summer-winter changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer representative and service agency for all major equipment items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for final acceptance.

1.26 RECORD DRAWINGS

- A. The Contractor shall obtain at his expense one (1) set of construction Contract Drawings including non-reproducible black and white prints and one set of reproducible mylars for the purpose of recording record conditions.
- B. The Contractor shall perform all survey work required for the location and construction of the work and to record information necessary for completion of the record drawings. Record drawings shall show the actual location of the constructed facilities in the same manner as was shown on the bid drawings. All elevations and dimensions shown on the drawings shall be verified or corrected so as to provide a complete and accurate record of the facilities as constructed.
- C. It shall be the responsibility of the Contractor to mark each sheet of the non-reproducible drawings in pencil and to record thereon in a legible manner, any and all approved field changes and conditions as they occur. A complete file of approved field sketches, diagrams, and other changes shall also be maintained. At completion of the work, each sheet of record prints, plus all approved field sketches and diagrams shall be used in preparation of the mylar reproducible record drawings.
- D. Completed reproducible mylar drawings shall be certified as reflecting record conditions and submitted to the engineer for approval.

1.27 ADDITIONAL ENGINEERING SERVICES

- A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any monies owed to the Contractor.

1.28 FINAL INSPECTION

- A. Upon completion of all punch list items, the Contractor shall provide a copy of the punch list back to the Engineer with each item noted as completed or the current status of the item. Upon receipt, the Engineer will schedule a final inspection.

1.29 ALL TRADES TEMPORARY HEAT

- A. Refer to the Standard General Conditions of the contract for Construction and Supplemental General Conditions.

1.30 PLUMBING TEMPORARY FACILITIES

- A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

1.31 CLEANING

- A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:
- B. Thoroughly clean entire installation, both exposed surfaces and interiors.
- C. Remove all debris caused by work.
- D. Remove tools, surplus, materials, when work is finally accepted.

END OF SECTION

**SECTION 22 0515
PLUMBING FIRESTOPPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping materials.
- B. Firestopping of all penetrations, openings, and interruptions to fire rated assemblies, whether indicated on drawings or not, including but not limited to piping, tubing and similar utilities passing through or penetrating fire rated walls and floor assemblies.

1.02 RELATED SECTIONS

- A. Refer to "Code Compliance Drawings" for location of fire rated assemblies. At a minimum, all corridor walls and all floors between stories have a 1 hour rating.

1.03 REFERENCES

- A. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
- C. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL - Fire Resistance Directory.
- D. Plumbing and Fuel Gas Codes of New York State.

1.04 FIRE-STOP SYSTEM PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration fire-stop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated walls including fire walls, fire partitions, fire barriers and smoke barriers.
 - 2. Fire-resistance-rated horizontal assemblies including floors and ceiling membranes of roof/ceiling assemblies.

1.05 SUBMITTALS

- A. See Section 01 3000 - Submittal Procedures for submittal process.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For each through-penetration fire-stop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include fire-stop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated. Submit UL Standard detail for each penetration type proposed.

1.06 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs which provide the specified fire ratings when tested in accordance with methods indicated.
 - 1. Listing in the current-year classification or certification books of UL will be considered as constituting an acceptable test report.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hilti.
- B. Nelson Fire Stop Products.
- C. Specified Technology.
- D. 3M Fire Protection Products.
- E. Approved equals meeting UL requirements.

2.02 MATERIALS

- A. Sealant Firestopping:
 - 1. Intumescent firestop sealant designed to expand when exposed to fire.
 - 2. Paintable.
 - 3. Fire Resistance: Up to 4 hours.
 - 4. Curing Time: 14 to 21 days.
 - 5. Elongation: 5 percent.
 - 6. Density: 1.5 g/cm³.
 - 7. Product: FS-ONE Intumescent Firestop Sealant manufactured by Hilti USA.
 - 8. Uses: Insulated and uninsulated metal pipes, with or without sleeve and plastic pipes.
- B. Silicone Sealant Firestopping:
 - 1. Silicone based firestop sealant that provides maximum movement in fire-rated joint applications and pipe penetrations.
 - 2. Not paintable.
 - 3. Fire Resistance: Up to 4 hours.
 - 4. Elongation: 25 percent.
 - 5. Product: CP 601S Elastomeric Firestop Sealant manufactured by Hilti USA.
 - 6. Uses: Joints in walls, floor to floor or fire compartments.
- C. Safing Insulation:
 - 1. Mineral-wool type insulation.
 - 2. Thickness: 1 inch to 1-1/2 inches.
 - 3. Density: 4 to 8 pcf.
 - 4. Product: THERMAFIBER Safing Insulation.
- D. Sleeves:
 - 1. Provide sleeves as required by section 1206.4 of the Mechanical Code.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this Section.

3.02 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration fire-stop systems to comply with fire-stop system manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration fire-stop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration fire-stop systems. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration fire-stop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 INSTALLATION

- A. General:
 1. Install materials in manner described in UL Detail and in accordance with manufacturer's instructions, completely closing openings.
- B. Installation:
 1. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.
 2. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
 3. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
 4. Fire Rated Surface:
 - a. Seal opening at floor, wall, partition, and roof as follows:
 - 1) Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - 2) Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - 3) Pack void with backing material.
 - 4) Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - b. Where plumbing piping penetrates a fire rated surface, install firestopping product in accordance with manufacturer's instructions.
 5. Non-Rated Surfaces:
 - a. Seal opening through non-fire rated wall, floor, ceiling, and roof opening as follows:
 - 1) Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - 2) Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - 3) Install type of firestopping material recommended by manufacturer.
 - b. Install floor plates or ceiling plate where piping penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - c. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of piping and tighten in place, in accordance with manufacturer's instructions.
- C. Identification:
 1. Identify through-penetration fire-stop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the fire-stop systems so that labels will be visible to anyone seeking to remove penetrating items or fire-stop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:
 - a. The words "Warning - Through-Penetration Fire-Stop System - Do Not Disturb. Notify Building Management of Any Damage."
 - b. Date of installation.
 - c. Through-penetration fire-stop system manufacturer's name.

3.04 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration fire-stop system manufacturers and that do not damage materials in which openings occur.

- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration fire-stop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration fire-stop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION

**SECTION 22 0553
PLUMBING IDENTIFICATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe Markers.

1.02 RELATED REQUIREMENTS

- A. Section 22 1005 - Plumbing Piping.

1.03 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Seton Identification Products.
- B. Brady Corporation
- C. Emed Company.

2.02 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 3/8 inch.
 - 3. Nameplate Height: 3/4 inch.
 - 4. Background Color: Black.

2.03 PIPE MARKERS AND ACCESSORIES

- A. Snap-on Marker: One piece wrap around type constructed of precoiled acrylic plastic with clear polyester coating, integral flow arrows, legend printed in alternating directions, 3/4 inch adhesive strip on inside edge, and 360 degree visibility.
- B. Strap-on Marker: Strip type constructed of precoiled acrylic plastic polyester coating, integral flow arrows, legend printed in alternating directions, factory applied grommets, and pair of stainless steel spring fasteners.
- C. Stick-on Marker: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating, and integral flow arrows for applications where flow arrow banding tape is not being used.
- D. Pipe Marker Legend:
 - 1. Outside Diameter of Pipe or Insulation 3/4 to 1-1/4 inch:
 - a. Letter size: 1/2 inch.
 - b. Length of color field: 8 inches.
 - 2. Outside Diameter of Pipe or Insulation 1-1/2 to 2 inches:
 - a. Letter size: 3/4 inch.
 - b. Length of color field: 8 inches.
 - 3. Outside Diameter of Pipe or Insulation 2-1/2 to 6 inches:
 - a. Letter size: 1-1/4 inch.
 - b. Length of color field: 12 inches.
 - 4. Outside Diameter of Pipe or Insulation 8 inches and greater:
 - a. Letter size: 2-1/2 inch.

- b. Length of color field: 18 inches.
- E. Color: Conform to ANSI A13.1.
- F. Banding Tapes: Pressure sensitive adhesive backed type constructed of vinyl with clear polyester coating.
 - 1. Plain Tape: Unprinted type; color to match pipe marker background.
 - 2. Flow Arrow Tape: Printed type with integral flow arrows; color to match pipe marker background.

2.04 UNDERGROUND PLASTIC PIPE MARKERS

- A. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.05 PIPE SERVICE IDENTIFICATION TAGS

- A. Type: No. 19 B&S gage brass, with 1/4 inch high pipe service abbreviated legend on one line, over 1/2 inch high pipe size legend in inches, both deep stamped and black filled; and 3/16 inch top hole for fastener.
- B. Size: 2 inch square tag.
- C. Fasteners: Brass "S" hook or brass jack chain of size required for pipe to which tag attached.

2.06 VALVE SERVICE IDENTIFICATION TAGS

- A. Type: No. 19 B&S gage brass, with 1/4 inch high pipe service abbreviated legend on one line, over 1/2 inch high pipe size legend in inches, both deep stamped and black filled; and 3/16 inch top hole for fastener.
- B. Size: 1-1/2 inch dia. round.
- C. Fasteners: Brass "S" hook or brass jack chain of size as required for valve stem or handle to which tag is attached.

2.07 VALVE SERVICE IDENTIFICATION CHART FRAMES

- A. Type: Satin finished extruded aluminum frame with rigid clear plastic glazing, size to fit 8-1/2 x 11 inch valve chart.

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete testing, insulation, and finish painting work prior to completing the Work of this Section.
- B. Clean pipe and equipment surfaces with cleaning solvents prior to installing piping identification or equipment tags.
- C. Remove dust from insulation surfaces with clean clothes prior to installing piping or equipment identification.

3.02 INSTALLATION

- A. Install the Work of this Section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.
- B. Name Plates:
 - 1. Install plastic nameplates on properly prepared and dry surface with adhesive and ensure permanent adhesion.
- C. Pipe and Valve Service Identification Tags:
 - 1. Install tags with "S" hooks and corrosion resistant chain.
- D. Stick-On Pipe Markers:
 - 1. Install minimum of 2 markers at each specified location, 90 degrees apart on visible side of pipe.
 - 2. Encircle ends of pipe markers around pipe or insulation with banding tape with one inch lap. Use plain banding tape on markers with integral flow arrows, and flow arrow banding tape on markers without integral flow arrows.
- E. Underground Plastic Pipe Markers:

1. Install 6 to 8 inches below finished grade, directly above buried pipe.

3.03 PIPING IDENTIFICATION

- A. Piping Identification Types:
 1. Piping or Insulation under 3/4 inch od: Pipe identification tags.
 2. Piping or Insulation 1 inch and larger: Snap-on pipe markers or stick-on pipe markers.
- B. Identify exposed piping, bare or insulated, as to content and direction of flow, with the following exceptions:
 1. Piping in non-walk-in tunnels or underground conduits between manholes.
 2. Piping in furred spaces or suspended ceilings, except at valve access panels where valves and piping shall be identified as specified for exposed piping systems.
 3. Piping exposed in finished spaces such as offices, classrooms, wards, toilet rooms, shower rooms, and corridors.
- C. Locate piping identification to be visible from exposed points of observation.
 1. Locate piping identification at valve locations; at points where piping enters and leaves a partition, wall, floor or ceiling, and at intervals of 20 feet on straight runs.
 2. Where 2 or more pipes run in parallel, place printed legend and other markers in same relative location.

3.04 VALVE IDENTIFICATION

- A. Valve Service Identifications Tags:
 1. Tag control valves, except valves at equipment, with brass tag fastened to the valve handle or stem, marked to indicate service and numbered in sequence for the following applications:
 - a. Domestic water valves controlling mains, risers, and branch run outs.
 - b. Gas valves controlling mains, risers, and branch run outs.
- B. Valve Service Identification Charts:
 1. Provide two (2) framed valve charts for each piping system specified to be provided with valve identification tags. Type charts on 8-1/2 x 11 inch heavy white bond paper, indicating valve number, service and location.
 2. Hang framed charts in main boiler/mechanical room at location as directed by Owner.

3.05 EQUIPMENT IDENTIFICATION

- A. Identify uninsulated plumbing equipment by means of plastic nameplates:
 1. Letter Size: 3/8 inches height.
- B. Small inline pumps may be identified with tags equivalent as specified for pipe service.
- C. Locations: Co-locate nameplates with manufacturer's equipment nameplates where readily visible. Where view of manufacturer's nameplate is obstructed locate nameplate to be readily visible.
- D. Equipment Identification Legend:
 1. Equipment identification shall match tags as scheduled on drawings.

END OF SECTION

**SECTION 22 0719
PLUMBING PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 22 1005 - Plumbing Piping.

1.03 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- F. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
- H. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- K. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 01 3000 - Submittal Procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than five years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of documented experience.
- C. Regulatory Requirements:
 - 1. Insulation installed inside buildings, including laminated jackets, mastics, sealants and adhesives shall have a Fire Spread/Smoke Developed Rating of 25/50 or less based on ASTM E 84, NFPA 255, and UL 723.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 PIPING INSULATION

- A. Fibrous Glass (Mineral Fiber) Insulation: Composed principally of fibers manufactured from rock, slag, or glass, with or without binders, and asbestos free.
 - 1. Manufacturers:
 - a. Johns Manville Corporation.
 - b. Knauf Fiber Glass.
 - c. Owens Corning Corporation.
 - 2. Preformed Pipe Insulation: Minimum density 3 pcf; ASTM C 547 and ASTM C 795.
 - a. Class 1 (Suitable for Temperatures Up to 450 degrees F): 'K' value of 0.26 at 75 degrees F.
 - 3. Premolded Fitting Insulation: Minimum density 4.0 pcf, K of 0.26 at 75 degrees F; ASTM C 547, Class 1.
 - 4. Insulation Inserts for PVC Fitting Jackets: Minimum density 1.5 pcf, K of 0.28 at 75 degrees F; ASTM C 553, Type III.
 - a. Suitable for temperatures up to 450 degrees F.
- B. High Density Jacketed Insulation Inserts for Hangers and Supports:
 - 1. Manufacturers:
 - a. Johns Manville Corporation.
 - b. Knauf Fiber Glass.
 - c. Owens Corning Corp.
 - 2. For Use with Fibrous Insulation:
 - a. Cold Service Piping:
 - 1) Polyurethane Foam: Minimum density 4 pcf, K of 0.13 at 75 degrees F, minimum compressive strength of 125 psi.
 - b. Hot Service Piping:
 - 1) Calcium Silicate: Minimum density of 15 pcf, K of 0.50 at 300 degrees F; ASTM C 610.
 - 2) Perlite: Minimum density 12 pcf, K of 0.60 at 300 degrees F; ASTM C 610.
- C. Cements:
 - 1. Fibrous Glass Thermal Insulating Cement: Asbestos free; ASTM C 195.
 - 2. Fibrous Glass Hydraulic Setting Thermal Insulating and Finishing Cement: ASTM C 449/C 449M.

2.02 PLENUM WRAP FOR PVC PIPING IN RETURN AIR PLENUM SPACES

- A. Manufacturers:
 - 1. 3M - Building and Commercial Services Division, Fire Barrier Plenum Wrap 5A+
 - 2. Morgan Advanced Materials, PlenumWrap+
 - 3. Unifrax, FyreWrap 0.5
- B. General: Flexible fire-resistant wrap consisting of inorganic fiber blanket with a scrim-reinforced foil. Product provides a flexible, non-combustible enclosure for cables and pipes in return air plenums.
- C. Installation shall be in strict accordance with manufacturers written instructions, as shown on the approved shop drawing submittals. Wrap shall be a high-temperature fiber blanket thermal insulation encapsulated in a fiberglass-reinforced aluminized foil. Plenum wrap shall be nominal 6 pcf and have a nominal 1/2 inch thickness. The fiber blanket shall have a continuous use limit in excess of 1,832F. Flame Spread Index and Smoke Developed Index of the foil encapsulated blanket shall be <25 / <50.

2.03 INSULATION JACKETS AND FITTING COVERS

- A. Laminated Vapor Barrier Jackets for Piping Insulation: Factory applied by insulation manufacturer, conforming to ASTM C 1136, Type I.
 - 1. Type I: Reinforced white kraft and aluminum foil laminate with kraft facing out.

- a. Pipe Jackets: Furnished with integral 1-1/2 inch self sealing longitudinal lap, and separate 3 inch wide adhesive backed butt strips.
- 2. Type II: Reinforced aluminum foil and kraft laminate with foil facing out.
- 3. Laminated vapor barrier jackets are not required for flexible elastomeric foam insulation.
- B. Premolded PVC Fitting Jackets:
 - 1. Constructed of high impact, UV resistant PVC.
 - a. ASTM D 1784, Class 14253-C.
 - b. Working Temperature: 0-150 degrees F.

2.04 ADHESIVES, MASTICS, AND SEALERS

- A. Vapor Seal Adhesive (Fibrous Glass Insulation): Childers' CP-82, Epolux's Cadoprene 400, Foster's 85-75 or 85-20.
- B. Vapor Barrier Mastic/Joint Sealer (Fibrous Glass Insulation): Childers' CP-30, Epolux's Cadalar 670, Foster's 95-44 or 30-35.
- C. Adhesive (Reinforcing Membrane): Childers' Chil-Spray WB CP-56.
- D. Mastic (Reinforcing Membrane): Childers' AK-CRYL CP-9.

2.05 MISCELLANEOUS MATERIALS

- A. Insulation Fasteners:
 - 1. Acceptable Manufacturers: Duro-Dyne Corp.; Erico Fastening Systems, Inc.
 - 2. Type: Weld pins, complete with self-locking insulation retaining washers.
- B. Pressure Sensitive Tape for Sealing Laminated Jackets:
 - 1. Acceptable Manufacturers: Alpha Associates, Childers, Ideal Tape, Morgan Adhesive.
 - 2. Type: Same construction as jacket.

PART 3 EXECUTION

3.01 PREPARATION

- A. Perform the following prior to starting insulation Work:
 - 1. Install all hangers, supports, and appurtenances in their permanent locations.
 - 2. Complete testing of piping.
 - 3. Clean and dry all surfaces to be insulated.

3.02 INSTALLATION, GENERAL

- A. Install the Work of this Section in accordance with manufacturer's printed installation instructions unless otherwise specified.
- B. Provide continuous piping insulation and jacketing when passing thru interior wall, floor, and ceiling construction.
 - 1. At Through Penetration Firestops: Coordinate insulation densities with the requirements of approved firestop system being installed. See Section 22 0515.
 - a. Insulation densities required by approved firestop system may vary with the densities specified in this Section. When this occurs use the higher density insulation.
- C. Individual piping runs shall have consistent insulation type.
- D. Apply Insulation to completely cover entire surface of piping. Do not insulate over weld certification stamps.

3.03 INSTALLATION AT HANGERS AND SUPPORTS

- A. Reset and realign hangers and supports if they are displaced during insulation installation.
- B. Install high density jacketed insulation inserts at hangers and supports for insulated piping as specified.
 - 1. Insulation Inserts For Use with Fibrous Glass Insulation:
 - a. Where clevis hangers are used, install insulation shields and high density jacketed insulation inserts between shield and pipe.

- b. Where insulation is subject to compression at points over 180 degrees apart, e.g. riser clamps, U-bolts, or trapezes, fully encircle pipe with 2 protection shields and 2 high density jacketed fibrous glass insulation inserts within supporting members.
 - 1) Exception: Locations where pipe covering protection saddles are specified for hot service piping, 6 inch and larger.

3.04 INSTALLATION OF FIBROUS GLASS COLD SERVICE INSULATION

- A. Install insulation materials with a field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket, unless otherwise specified.
- B. Piping:
 1. Butt insulation joints together.
 2. Continuously seal joints with minimum 1-1/2 inch wide self-sealing longitudinal jacket laps and 3-inch wide butt adhesive backed strips, or 3 inch wide pressure sensitive sealing tape of same material as jacket.
 3. Bed insulation in a 2-inch wide band of vapor barrier mastic, and vapor seal exposed ends of insulation with vapor barrier mastic at each butt joint between pipe insulation and equipment, fittings or flanges at the following intervals:
 - a. Horizontal Pipe Runs: 21 ft.
 - b. Vertical Pipe Runs: 9 ft.
- C. Fittings, Valves, Flanges and Irregular Surfaces:
 1. Insulate with mitre cut or pre-molded fitting insulation of same material and thickness as adjoining pipe insulation.
 2. Secure insulation in place with 16 gage wire, with ends twisted and turned down into insulation.
 3. Butt fitting, valve, and flange insulation against pipe insulation and bond with insulating cement.
 4. Insulate valves up to and including bonnets, without interfering with packing nuts.
 5. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
 6. When insulating cement has dried, seal fitting, valve and flange insulation by embedding a layer of reinforcing membrane of 4 oz. canvas jacket between 2 flood coats of vapor barrier mastic, each 1/8 inch thick wet.
 7. Lap reinforcing membrane or canvas on itself and adjoining pipe insulation at least 2 inches.
 8. Trowel, brush, or rubber glove outside coat over entire insulated surface.
- D. Fittings, Valves, Flanges and Irregular Surfaces - Alternate:
 1. Apply one piece pre-molded PVC fitting covers with fibrous glass insulation inserts with galvanized coated tack fasteners. Tape circumferential joint between insulation and premolded fitting cover with 2 inch wide pressure sensitive polyvinyl tape.
 - a. Exception: Provide additional insulation inserts on service operating at under 45 degrees F or where insulation thickness exceeds 1-1/2 inches. Ensure that insulation is adequate to prevent PVC fitting jacket temperature from falling below 45 degrees F.

3.05 INSTALLATION OF FIBROUS GLASS HOT SERVICE INSULATION

- A. Install insulation materials with field or factory applied ASTM C 1136 Type I laminated vapor barrier jacket unless otherwise specified.
- B. Canvas Jackets on Piping, Fittings, Valves, Flanges, Unions, and Irregular Surfaces:
 1. For piping 2 inch size and smaller: 4 oz per sq yd unless otherwise specified.
 2. For piping over 2 inch size: 6 oz per sq yd unless otherwise specified.
- C. Piping:
 1. Butt insulation joints together.
 2. Continuously seal joints with minimum 1-1/2 inch wide self-sealing longitudinal jacket laps and 3-inch wide butt adhesive backed strips, or 3 inch wide pressure sensitive sealing tape of same material as jacket.
 3. Fill voids in insulation at hanger with insulating cement.
 4. Exceptions:

- a. Piping in Accessible Shafts, Attic Spaces, Crawl Spaces, Unfinished Spaces, and Concealed Piping: Butt insulation joints together and secure with minimum 1-1/2" wide longitudinal jacket laps and 3 inch wide butt strips of same material as jacket, with outward clinching staples on maximum 4 inch centers. Fill voids in insulation at hangers with insulating cement.
- b. Piping in Tunnels: Butt insulation joints together and secure with minimum 1-1/2" wide longitudinal jacket laps and 3 inch wide butt strips, of same material as jacket, with outward clinching staples on maximum 4 inch centers and 16 gage wires a minimum of 4 loops per section. Fill voids in insulation with insulating cement.
- 5. Fittings, Valves, Flanges and Irregular Surfaces:
 - a. Insulate with mitre cut or pre-molded fitting insulation of same material and thickness as adjoining pipe insulation.
 - b. Secure insulation in place with 16 gage wire, with ends twisted and turned down into insulation.
 - c. Butt fitting, valve, and flange insulation against pipe insulation and bond with insulating cement.
 - d. Insulate valves up to and including bonnets, without interfering with packing nuts.
 - e. Apply leveling coat of insulating cement to smooth out insulation and cover wiring.
 - f. When insulating cement has dried, coat insulated surface with lagging adhesive, and apply 4 oz. or 6 oz. canvas jacket as required by pipe size.
 - 1) Lap canvas jacket on itself and adjoining pipe insulation at least 2 inches.
 - 2) Size entire canvas jacket with lagging adhesive.
 - g. Exceptions:
 - 1) Insulate fittings, valves, and irregular surfaces 3 inch size and smaller with insulating cement covered with 4 oz or 6 oz canvas jacket as required by pipe size. Terminate pipe insulation adjacent to flanges and unions with insulating cement, troweled down to pipe on a bevel.
 - 2) Sizing of canvas surface is not required on fittings, valves, flanges, and irregular surfaces in concealed piping, piping in accessible shafts, attic spaces, crawl spaces, unfinished spaces, and tunnels.
- 6. Fittings, Valves, Flanges and Irregular Surfaces - Alternate:
 - a. Apply one piece pre-molded PVC fitting covers with fibrous glass insulation inserts with galvanized coated tack fasteners. Tape circumferential joint between insulation and premolded fitting cover with 2 inch wide pressure sensitive polyvinyl tape.
 - 1) Exception: Provide additional insulation inserts on service operating at over 250 degrees F or where insulation thickness exceeds 1-1/2 inches. Ensure that insulation is adequate to prevent PVC fitting jacket temperature from exceeding 150 degrees F.

3.06 SCHEDULE OF PIPING INSULATION

- A. Insulate all cold service and hot service piping, and appurtenances except where otherwise specified.
- B. Plumbing Piping Systems:
 - 1. Domestic Hot Water Supply (105 to 140 degrees F):
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: Up to 1-1/4 inch.
 - (a) Thickness: 1 inch.
 - 2) Pipe Size Range: 1-1/2 inch and over.
 - (a) Thickness: 1-1/2 inch.
 - 2. Domestic Hot Water Recirculation:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - (a) Thickness: 1 inch.
 - 3. Domestic Cold Water:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - (a) Thickness: 1/2 inch.
 - 4. Roof Drain Bodies:
 - a. Glass Fiber Insulation:

- 1) Thickness: 1 inch.
 5. Roof Drainage Within 10 Feet of the Exterior:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - (a) Thickness: 1 inch.
 6. Roof Drainage Run Horizontal at Roof Level and all risers down to below finish floor:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - (a) Thickness: 1 inch.
 7. Plumbing Vents Within 10 Feet of the Exterior:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - (a) Thickness: 1 inch.
- C. Schedule of Items Not to be Insulated:
1. Chrome plated piping, unless otherwise specified.
 2. Water heater blow-off piping.
 3. Air vents, pressure reducing valves, pilot lines, safety valves, relief valves.
 4. Piping buried in the ground, unless otherwise specified herein.
 5. Items installed by others, unless otherwise specified herein.
 6. Sanitary drainage piping, unless otherwise specified herein.
 7. Sprinkler and standpipe piping, unless otherwise specified.

END OF SECTION

**SECTION 22 1005
PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe, pipe fittings, valves, and connections for piping systems.
 - 1. Sanitary sewer.
 - 2. Domestic water.
 - 3. Storm water.
 - 4. Gas.
 - 5. Flanges, unions, and couplings.
 - 6. Pipe hangers and supports.
 - 7. Valves.

1.02 RELATED REQUIREMENTS

- A. Section 22 0553 - Plumbing Identification.
- B. Section 22 0719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- D. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- E. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- F. ASME B31.1 - Power Piping.
- G. ASME B31.9 - Building Services Piping.
- H. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers.
- I. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- J. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- L. ASTM B32 - Standard Specification for Solder Metal.
- M. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- N. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
- O. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- P. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- Q. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- R. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- S. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- T. 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.
- U. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- V. AWWA C651 - Disinfecting Water Mains.

- W. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
- X. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- Y. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- Z. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- AA. MSS SP-139 - Copper alloy gate, globe, angle and check valve for low pressure/low temperature plumbing applications; 2010.
- BB. NSF 61 - 2003e Drinking water system components - Health effects.

1.04 SUBMITTALS

- A. See Section 01 3000 - Submittal Procedures
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- C. Welder Qualifications: Certified in accordance with ASME (BPV IX).
- D. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C 564 neoprene gaskets.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.02 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C 564 neoprene gaskets.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

- C. Copper Tube: ASTM B306, DWV.
 - 1. Fittings: ASME B16.29, wrought copper or ASME B16.32 solvent.
 - 2. Joints: ASTM B32, alloy Sn50 solder.
- D. PVC Pipe: ASTM D1785 Schedule 40, or ASTM D2241 SDR 26 with not less than 150 psi pressure rating.
 - 1. Fittings: ASTM D2466, PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Pipe: ASTM B42, hard drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
 - 2. Joints: ASTM B 32, alloy Sn95 solder.

2.04 WATER PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.
 - 3. Joints: Grooved mechanical couplings.

2.05 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C 564 neoprene gaskets.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.06 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C 564 neoprene gaskets.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.
- C. PVC Pipe: ASTM D1785 Schedule 40, or ASTM D2241 SDR 26 with not less than 150 psi pressure rating.

2.07 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: ASME B31.1, welded.
 - 3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.08 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: NFPA 54, threaded or welded to ASME B31.1.
 - 3. Corrosion Protection for Exterior Piping:
 - a. Primer: Touch-up with rust-inhibitive primer recommended by top coat manufacturer.
 - b. Gloss: Two coats of latex enamel; S-W DTM Acrylic Coating, B66-100 or approved equal.
 - 1) Color: Yellow.
 - 2) 2.5-4.0 mils Dry per coat.

2.09 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Ferrous Pipe Sizes 3 Inches and Under:
 - 1. Class 150 malleable iron threaded unions.
- B. Unions for Copper Tube and Pipe 2 Inches and Under:
 - 1. Class 150 bronze unions with soldered joints.
- C. Flanges for Pipe Size Over 1 Inch:
 - 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.10 PIPE HANGERS AND SUPPORTS

- A. All plumbing piping shall be supported in accordance with the Plumbing Code of New York State. Hangers, anchors and supports shall support the piping and the contents of the piping. Hangers and strapping shall be of approved material that will not promote galvanic action.
- B. Plumbing Piping - Drain, Waste, and Vent:
 - 1. Conform to ASME B31.9.
 - 2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 - 7. Vertical Support: Steel riser clamp.
 - 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- C. Plumbing Piping - Water:
 - 1. Conform to ASME B31.9.
 - 2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.
 - 5. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
 - 6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
 - 7. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 8. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 - 9. Vertical Support: Steel riser clamp.
 - 10. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 11. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
 - 12. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.11 BALL VALVES

- A. Manufacturers:
 - 1. Conbraco Industries: www.conbraco.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.

- B. Construction, 2-1/2 inch and Smaller: MSS SP-110 & MSS SP-139 low lead, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, full port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.

2.12 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Watts, Inc: www.watts.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Up to 2 Inches:
 - 1. MSS SP-80 & MSS SP-139 low lead, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends.
- C. Over 2 Inches:
 - 1. MSS SP-71 & MSS SP-139 low lead, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.

2.13 STRAINERS

- A. Manufacturers:
 - 1. Watts.: www.watts.com.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Size 2 inch and Under:
 - 1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
 - 2. MSS SP-139 low lead Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 1-1/2 inch to 4 inch:
 - 1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.
- H. Provide access where valves and fittings are not exposed.
- I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly. Terminate at least 18 inches above roof.

- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Excavate in accordance with Section 31 2316.
- L. Backfill in accordance with Section 31 2323.
- M. Install bell and spigot pipe with bell end upstream.
- N. Install valves with stems upright or horizontal, not inverted.
- O. Use non-hardening pipe dope on gas piping threads, do not use thread seal tape.
- P. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- Q. Sleeve pipes passing through partitions, walls and floors.
- R. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- S. Pipe Hangers and Supports:
 - 1. Support horizontal piping as scheduled.
 - 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Support vertical piping as scheduled.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Provide copper plated hangers and supports for copper piping.
 - 8. Prime coat exposed steel hangers and supports. Refer to Section 09 9000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - 9. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22 0548.
 - 10. Support cast iron drainage piping at every joint.

3.04 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Install ball valves for throttling, bypass, or manual flow control services.
- E. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- F. Provide spring loaded check valves on discharge of water pumps.

3.05 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope for pipes 2-1/2" diameter and less, 1/8 inch per foot slope for pipes 3" to 6" in diameter and 1/16 inch per foot slope for pipes 8" and larger in diameter.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points with capped drain valves.

3.06 TESTING AND INSPECTIONS

- A. New plumbing systems and parts of existing systems that have been altered, extended or repaired shall be tested in accordance with the Plumbing Code of New York State or the authority having jurisdiction to disclose leaks and defects.
- B. Pressure test piping systems inside buildings, at the roughing-in stage of installation, before piping is enclosed by construction Work, and at other times as directed. Perform test operations in sections as required and directed, to progress the Work in a satisfactory manner and not delay the general construction of the building. Valve or cap-off sections of piping to be tested, utilizing valves required to be installed in the permanent piping systems, or temporary valves or caps as required to perform the Work.
- C. The contractor shall make the applicable tests prescribed below to determine compliance with the provisions of the Plumbing Code of New York State. The contractor shall give reasonable advance notice to the code official when the plumbing work is ready for tests. The equipment, material, power and labor necessary for the inspection and test shall be furnished by the contractor. All plumbing system piping shall be tested with either water or air. Plastic piping shall not be tested with air.
- D. Piping shall be tight under test and shall not show loss in pressure or visible leaks, during test operations or after the minimum duration of time as specified. Remove piping which is not tight under test; remake joints and repeat test until no leaks occur.
- E. Required Inspections:
 - 1. Underground inspection shall be made after trenches or ditches are excavated and bedded, piping installed, and before any backfill is put in place.
 - 2. Rough-in inspection shall be made of completed portions of all sanitary, storm and water distribution piping, after the framing, fireblocking, firestopping, draft-stopping and bracing for that portion is in place, and prior to the installation of wall or ceiling membranes.
 - 3. Final inspection shall be made after the building is completed, all plumbing fixtures are in place and properly connected, and the structure is ready for occupancy.
- F. Drainage and Vent Water Test:
 - 1. A water test shall be applied to the drainage system either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test, and each section filled with water, but no section shall be tested with less than a 10-foot head of water. In testing successive sections, at least the upper 10-foot of the next proceeding section shall be tested so that no joint or pipe in the building, except the uppermost 10 feet of the system, shall have been submitted to a test of at least 10-foot head of water. Test by filling the entire system with water, and allowing to stand for 3 hours, with no noticeable loss of water.
- G. Drainage and Vent Air Test:
 - 1. An air test shall be made by forcing air into the system until there is a uniform gauge pressure of 5 pounds per square inch (psi) or sufficient to balance a 10-inch column of mercury. This pressure shall be held for a test period of 3 hours with no noticeable loss. Any adjustments to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period.
- H. Drainage and Vent Final Test:
 - 1. After the plumbing fixtures have been set and their traps filled with water, the entire drainage system shall be submitted to final tests. The final test shall be visual and in sufficient detail to determine compliance with the provisions of the Plumbing Code of New York State.
- I. Domestic Water (Potable Cold, Domestic Hot and Recirculation) Inside Buildings:
 - 1. Before fixtures, faucets, trim and accessories are connected, perform hydrostatic test at 125 psig minimum for 4 hours.
 - 2. After fixtures, faucets, trim and accessories are connected, perform hydrostatic retest at 75 psig for 4 hours.
 - 3. The water utilized for the tests shall be obtained from a potable water source of supply.
- J. Storm Drainage System Test:

1. Storm drainage systems within a building shall be tested by water or air.
2. A water test shall be applied to the drainage system either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test, and each section filled with water, but no section shall be tested with less than a 10-foot head of water. In testing successive sections, at least the upper 10-foot of the next proceeding section shall be tested so that no joint or pipe in the building, except the uppermost 10 feet of the system, shall have been submitted to a test of at least 10-foot head of water. Test by filling the entire system with water, and allowing to stand for 3 hours, with no noticeable loss of water.
3. An air test shall be made by forcing air into the system until there is a uniform gauge pressure of 5 pounds per square inch (psi) or sufficient to balance a 10-inch column of mercury. This pressure shall be held for a test period of 3 hours with no noticeable loss. Any adjustments to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period.

3.07 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. New and repaired potable water systems shall be purged of deleterious matter and disinfected prior to utilization.
- B. The method to be followed for the disinfection of potable water systems shall be in accordance with the applicable NYSDOH Regulations.
 1. Completely fill the piping, including water storage equipment if installed, with a water solution containing 50 mg/l available chlorine and allow to stand for 24 hours. Operate all valves during this period to ensure their proper disinfection. After the 24 hour period, the chlorine residual shall be 25 mg/l or greater. If not, flush and repeat chlorination procedure.
 2. After the retention period, discharge the solution into an approved waste and flush the system thoroughly with potable water until substantially all traces of chlorine are removed. Drain and flush water storage equipment if installed.
- C. Collect samples for bacteriological analysis in accordance with AWWA C651.
- D. Repeat procedure if bacteriological results are not satisfactory.
- E. Submit bacteriological test results to the Architect/Engineer prior to placing the system in service. Prevent re-contamination of the piping during this phase of the work.

3.08 SCHEDULES

- A. Pipe Hanger Spacing.
 1. Cast Iron Piping
 - a. All Sizes:
 - 1) Maximum Horizontal Spacing: 5 ft. (May be increased to 10 ft. where 10-foot pipe lengths are installed.)
 - 2) Maximum Vertical Spacing: 15 ft.
 2. Copper or Copper-Alloy Tubing.
 - a. 1-1/4" diameter and smaller:
 - 1) Maximum Horizontal Spacing: 6 ft.
 - 2) Maximum Vertical Spacing: 10 ft.
 - b. 1-1/2" diameter and larger:
 - 1) Maximum Horizontal Spacing: 10 ft.
 - 2) Maximum Vertical Spacing: 10 ft.
 3. PVC Pipe.
 - a. All Sizes:
 - 1) Maximum Horizontal Spacing: 4 ft.
 - 2) Maximum Vertical Spacing: 10 ft. (midstory guide for sizes 2" and smaller)
 4. Steel Pipe.
 - a. All Sizes:
 - 1) Maximum Horizontal Spacing: 12 ft.

2) Maximum Vertical Spacing: 15 ft.

END OF SECTION

**SECTION 22 1006
PLUMBING PIPING SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Floor drains.
- B. Cleanouts.
- C. Hydrants.
- D. Water hammer arrestors.
- E. Grease Interceptor.
- F. Dilution Tanks

1.02 RELATED REQUIREMENTS

- A. Section 22 1005 - Plumbing Piping.
- B. Section 22 4000 - Plumbing Fixtures.
- C. Section 22 3000 - Plumbing Equipment.

1.03 REFERENCE STANDARDS

- A. ASME A112.6.3 - Floor and Trench Drains.
- B. NSF 61 - Drinking Water System Components - Health Effects.
- C. PDI-WH 201 - Water Hammer Arresters.

1.04 SUBMITTALS

- A. See Section 01 3000 - Submittal Procedures.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- E. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.
- F. Operation Data: Indicate frequency of treatment required for interceptors.
- G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 DRAINS

- A. Floor Drain (FD-A):
 - 1. ASME A112.6.3; epoxy coated cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and square, adjustable nickel-bronze strainer. Provide drain with 3" outlet and trap below floor, or as indicated on drawings.
 - 2. Manufacturers:
 - a. Josam Company: www.josam.com.
 - b. Watts Water Technologies; Model FD-100-L: www.watts.com.
 - c. Zurn Industries, Inc: www.zurn.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

3. Accessories: Floor drain trap seal.
 - a. Manufacturers:
 - 1) ProVent Systems, Inc.: www.trapguard.com.
 - 2) Sure Seal Manufacturing; Model SS3000: www.thesureseal.com.
 - 3) Substitutions: See Section 01 6000 - Product Requirements.
- B. Linear Drain (LD-A):
1. Construction:
 - a. Low-Profile Linear Shower Drain Body: Type 316L stainless steel, with 1 inch wide trough running the length of the strainer, sloped on the bottom to drain into vertical waste pipe. A 1 inch wide flange to which the waterproofing membrane is attached shall extend from all four sides of the trough. Frame shall be welded to drain body.
 - b. Removable Strainer: 18 gauge 304 stainless steel, bolt in type, 1-1/2 inches wide, that spans the length of the trough. Provide "Lines" pattern.
 - c. Flexible Flange: Made from material manufactured in compliance with requirements of ANSI A118.10, factory attached to drain body; one solid piece of membrane with a hole cut through for the trough and strainer, extending minimum 6 inches all the way around the drain.
 - d. Drain Waste Pipe: 2 inch inside diameter, extending 2 inches below the lowest point in the trough.
 - e. Slot Drain Cover: 1-1/2 inches wide.
 - f. All components of linear shower drains shall be removable, including the linear drain cover/strainer, providing access to waste pipe.
 - g. Plumber is responsible to provide correct length of linear drain and all accessories needed for proper installation. Refer to enlarged architectural plans for exact wall to wall dimensions.
 2. Manufacturers:
 - a. Proline Drain: Low-Profile Linear Shower Drains: Item Number PLD as manufactured by Quick Drain USA. Strainer Pattern: Lines. www.quickdrainusa.com
 - b. ACO Drain: www.quartzbyaco.com.
 - c. Substitutions: See Section 01 6000 - Product Requirements.
- C. Floor Sink (FS-A):
1. 8" square by 6" deep sanitary floor sink with white acid resistant porcelain enamel coated interior, loose set porcelain enamel coated cast iron 1/2 grate, flange with weep holes, and polypropylene dome bottom strainer.
 2. Manufacturers:
 - a. Josam Company: www.josam.com.
 - b. Watts Water Technologies; Model FS-710: www.watts.com.
 - c. Zurn Industries, Inc.: www.zurn.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
 3. Accessories: Floor drain trap seal.
 - a. Manufacturers:
 - 1) ProVent Systems, Inc.: www.trapguard.com.
 - 2) Sure Seal Manufacturing; Model SS3000: www.thesureseal.com.
 - 3) Substitutions: See Section 01 6000 - Product Requirements.

2.02 CLEANOUTS

- A. Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 2. Josam Company: www.josam.com.
 3. Watts Water Technologies; Model RD-940: www.watts.com.
 4. Zurn Industries, Inc: www.zurn.com.
 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Cleanouts at Interior Finished Floor Areas (DPCO):
1. Round cast nickel bronze access frame and non-skid cover, coated cast iron cleanout ferrule. Tapered thread. Bronze plug.

2. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored flush cover.
 3. Provide wrench for plug removal.
- C. Cleanouts at Interior Finished Wall Areas (WPCO):
1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

2.03 HYDRANTS

- A. Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jayrsmith.com/#sle.
 2. Zurn Industries, Inc: www.zurn.com/#sle.
 3. Watts Water Technologies: www.watts.com
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Interior Wall Hydrant (WH-A):
1. ASSE 1019; moderate climate, key operated, self-draining type with polished bronze lockable recessed box, 3/4" hose thread spout, lockshield and removable key, and integral vacuum breaker.
 2. Watts Water Technologies, Model HY-330; or approved equal.

2.04 WATER HAMMER ARRESTORS

- A. Manufacturers:
1. Precision Plumbing Products, Inc : www.pppinc.net
 2. Watts Regulator Company: www.watts.com.
 3. Zurn Industries, Inc: www.zurn.com/#sle.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Water Hammer Arrestors:
1. Copper construction, piston type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range 34 to 250 degrees F and maximum 150 psi working pressure.

2.05 SUMPS AND INTERCEPTORS

- A. Manufacturers:
1. Schier Products, model GB-50 ; www.schierproducts.com
 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Grease Interceptors:
1. Construction:
 - a. Material: Seamless, rotationally-molded polyethylene.
 - b. Rough-in: Fully recessed flush with floor (suspended) installation with anchor flange.
 - c. Interceptor shall be certified to ASME A112.14.3 (Type D) and CSA B481.1, with adjustable cover adapter, Safety Star® access restrictor built into cover adapter.
 - d. Cover shall provide water/gas-tight seal and have minimum 2,000 lbs. load capacity (pedestrian traffic).
 - e. Interceptor shall be furnished with field cut riser model # FCR2 to enable access for below floor installation..
 - f. Interceptor shall be furnished with pumpout port kit model #PP3 to enable remote pump-out
 2. Unit Rating: 50 gpm flow and 439 lbs grease capacity.

2.06 DILUTION TANKS

- A. Manufacturers:
1. Josam Company: www.josam.com.
 2. Orion Fittings; Model Style 11: www.orionfittings.com.
 3. Zurn Industries, Inc : www.zurn.com.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. 2 gallon anti-siphon dilution tank with seamless construction manufactured from high density polyethylene. Direct connection to sink.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- B. Install floor cleanouts at elevation to accommodate finished floor.
- C. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to each fixture or group of fixtures.

**SECTION 22 3000
PLUMBING EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water softeners.
- B. Sump pumps.

1.02 RELATED REQUIREMENTS

- A. Section 26 2726 - Wiring Devices: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ICC (IPC) - International Plumbing Code.
- B. NFPA 70 - National Electrical Code.
- C. UL 778 - Standard for Motor-Operated Water Pumps.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal process.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Indicate pump type, capacity, power requirements.
 - 3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 4. Provide electrical characteristics and connection requirements.
- C. Shop Drawings:
 - 1. Indicate heat exchanger dimensions, size of tapings, and performance data.
 - 2. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tapings, and drains.
- D. Manufacturer's Instructions.
- E. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum 5 years of documented experience.
- B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
- C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.07 WARRANTY

- A. The warranty period shall be the standard manufacturer's coverage from the date of installation.

PART 2 PRODUCTS

2.01 WATER SOFTENERS

- A. Manufacturers:

1. Watts Water Technologies; Series HTCA-300 model no M4110TA-39NT: www.watts.com
 2. Culligan International Company: www.culligan.com.
 3. Sterling Water Treatment: www.sterlingtonwatertreatment.com.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Performance:
1. Softening Capacity: 300,000 grains.
 2. Service Flow: 120 gpm.
- C. System: 10 cubic foot 3" duplex alternating softener with flow meter. Fully automated metered demand control valve certified to NSF/ANSI standards. Fully adjustable regeneration cycles. Corrosion resistant fiberglass tanks.
- D. Softener tanks (mineral tanks):
1. fiberglass construction: 24 inches diameter x 72" tall.
- E. Brine tank:
1. High density polyethylene tank: 30 inches diameter and 50 inches tall.

2.02 SUMP PUMPS, SP-1

- A. Manufacturers:
1. Armstrong Fluid Technology: www.armstronfluidtechnology.com.
 2. Goulds Water Technology, a xylem brand: www.goulds.com.
 3. Liberty Pumps, Inc ; Model FL51M-2: www.libertypumps.com.
 4. Zoeller Company: www.zoeller.com.
 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Type: Vertical centrifugal, direct connected, simplex arrangement.
- C. Casing: Cast iron volute with radial clearance around impeller, inlet strainer, slide away couplings.
- D. Impeller: engineered plastic ; non-clogging , keyed to AISI 1215 cold rolled steel shaft.
- E. Support: Lifting chains.
- F. Bearings: oil-fed cast iron upper and lower.
- G. Solids handling: 1/2" spherical solids.
- H. Sump: Existing concrete sump. Removable grating by others.
- I. Controls (simplex): NEMA 4X, Red Alarm Beacon and audible high water alarm, HOA switches, Run lights, alarm test & silence switches, auxiliary dry contact, integral auxiliary terminal board for remote alarm. Float operated mechanical alternator and corrosion resistant float.
1. Manufacturer:
 - a. Liberty pumps Company; model SXL24: www.libertypumps.com.
- J. Performance:
1. Motor: 1/2 hp, 120 volt, single phase, 60 Hz.
 2. RPM: 1725.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Pumps:
1. Ensure shaft length allows sump pumps to be located minimum 24 inches below lowest invert into sump pit and minimum 6 inches clearance from bottom of sump pit.
 2. Provide air cock and drain connection on horizontal pump casings.
 3. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.

4. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
5. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

END OF SECTION

**SECTION 22 4000
PLUMBING FIXTURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water closets.
- B. Urinals.
- C. Lavatories.
- D. Sinks.
- E. Service sinks.
- F. Electric water coolers.

1.02 RELATED REQUIREMENTS

- A. Section 07 9200 - Joint Sealants.
- B. Section 22 0719 - Plumbing Piping Insulation
- C. Section 22 1005 - Plumbing Piping.
- D. Section 22 1006 - Plumbing Piping Specialties.

1.03 REFERENCE STANDARDS

- A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2009.
- B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2006.
- C. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).
- D. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2005.
- E. ASME A112.19.2 - Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals; The American Society of Mechanical Engineers; 2008.
- F. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use); The American Society of Mechanical Engineers; 2008.
- G. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures; The American Society of Mechanical Engineers; 1994 (R2004).
- H. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals; The American Society of Mechanical Engineers; 2005.
- I. ASME A112.19.14 - Six Liter Water Closets Equipped with Dual Flushing Device; 2006.
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010.
- K. ISSFA-2 - Classification and Standards for Solid Surfacing Material; International Solid Surface Fabricators Association; 2001 (2007)
- L. NSF 61 - 2003e Drinking water system components - Health effects.

1.04 SUBMITTALS

- A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- B. Manufacturer's Instructions: Indicate installation methods and procedures.
- C. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.

1.06 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

PART 2 PRODUCTS

2.01 FLUSH VALVE WATER CLOSETS, WC-A:

- A. Bowl: Vitreous china, ASME A112.19.2, elongated rim, wall hung, siphon jet flush action, china bolt caps, installed at ADA height.
 - 1. Bowl: Vitreous china, ASME A112.19.2, 16-1/2 inch high floor mounted, elongated rim, siphon jet flush action, 1-1/2" top spud, china bolt caps.
 - 2. Flush Volume: 1.28 gallon, maximum.
 - 3. Flush Valve: Exposed (top spud).
 - 4. Flush Operation: Sensor operated.
 - 5. Manufacturers:
 - a. American Standard, Inc; Model 3351.101 - Afwall: www.americanstandard-us.com.
 - b. Kohler Company: www.kohler.com.
 - c. Sloan Valve Company: www.sloan.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- B. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
 - 1. Sensor-Operated Type: Chrome plated, with escutcheon, integral screwdriver stop, Solenoid operator, [Solar powered with battery back-up], infrared sensor and over-ride push button.
 - 2. Manufacturers:
 - a. Sloan Valve Company Model Solis 8111-1.28-OR: www.sloanvalve.com.
 - b. Coyne & Delany Co: www.coynedelany.com.
 - c. Zurn Industries, Inc: www.zurn.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- C. Seats:
 - 1. Manufacturers:
 - a. Bemis Manufacturing Company : www.bemismfg.com.
 - b. Church Seat Company; Model 9500SSC: www.churchseats.com.
 - c. Olsonite: www.olsonite.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.
- D. Water Closet Carriers:
 - 1. Manufacturers:
 - a. MIFAB Manufacturing Inc: www.mifab.com.
 - b. WATTS Water Technologies, Inc: www.watts.com.
 - c. Zurn Industries, Inc: www.zurn.com.
 - d. Substitutions: See Section 01 6000-Product Requirements.
 - 2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.02 FLUSH VALVE WATER CLOSETS, WC-B:

- A. Same as WC-A, but Installed at standard height for Non- ADA Installation.

2.03 WALL HUNG URINALS; UR-A:

- A. Wall Hung Urinal Manufacturers:
 - 1. American Standard, Inc; Model 6590.001 - Washbrook: www.americanstandard-us.com.
 - 2. Gerber Plumbing Fixtures LLC: www.gerberonline.com.
 - 3. Kohler Company: www.kohler.com.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Urinals: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier mounted at accessible height. Ultra High Efficiency. Flushing rim. Elongated 14" rim from finished wall. Washout flush action. Extended sides for privacy. 3/4" inlet spud. Outlet connection threaded 2" inside (NPTF). Strainer included
- C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories. 0.5 gallons per flush.
 - 1. Sensor-Operated Type: Chrome plated, with escutcheon, integral screwdriver stop; Solenoid operator, [Solar powered with battery back-up], infrared sensor and over-ride push button.
 - 2. Manufacturers:
 - a. Sloan Valve Company; Model SOLIS 8186-0.5-OR : www.sloanvalve.com.
 - b. Zurn Industries, Inc: www.zurn.com.
 - c. Delany Products: www.delaneyvalve.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- D. Carriers:
 - 1. Manufacturers:
 - a. WATTS Water Technologies, Inc: www.watts.com.
 - b. MIFAB Manufacturing, Inc: www.mifab.com.
 - c. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.04 WALL HUNG URINALS; UR-B:

- A. Same as UR-A but installed at standard height for non-ADA installation.

2.05 LAVATORIES; LAV-A:

- A. Lavatory Manufacturers:
 - 1. American Standard, Inc.; Model 0355.012: www.americanstandard-us.com.
 - 2. Kohler Company: www.kohler.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20-1/2 inch by 18-1/4 inch inch minimum, with 4 inch high back, rectangular basin with splash lip, front overflow, and soap depression.
 - 1. Drilling Centers: 3 holes in center.
- C. Mount at Accessible height.
- D. Supply Faucet Manufacturers:
 - 1. Sloan Faucets: Model EFX-275-4-SOL-ISM-CP-0.5GPM-MLM-IR-FCT: www.sloan.com
 - 2. Chicago Faucets: www.chicagofaucets.com
 - 3. Moen, Inc: www.moen.com
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- E. Supply Faucet: ASME A112.18.1; Sensor operated Vandal resistant assembly. 4" Trim Plate, Solar Power Supply, Integrated Side Mixer, Polished Chrome Finish, 0.5 gpm, Multi-laminar Spray, Infrared Sensor, BASYS Solar-Powered (with battery back-up) Deck-Mounted Mid Body Faucet.
- F. Accessories:
 - 1. Anti-scalding point of use lead free adjustable thermostatic mixing valve to conform to NYS plumbing code 419.5 and ASSE 1070. Built -in check valve and low pressure drop.
 - a. Manufacturer: Watts. Model LFUSG-B M3

- b. Substitutions: See Section 01 6000-Product Requirements.
 - 2. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
 - 3. Offset waste with perforated open strainer.
 - 4. Screwdriver stops.
 - 5. Flexible supplies.
 - 6. ADA pipe cover: Piping Safety Covers on all exposed traps and supply lines: Truebro Lav-Guard.
- G. Carrier (when not using existing):
- 1. Manufacturers:
 - a. JOSAM Company: www.josam.com.
 - b. Zurn Industries, Inc.: www.zurn.com.
 - c. MIFAB Manufacturing, Inc.: www.mifab.com.
 - d. WATTS Water Technologies: www.watts.com.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

2.06 LAVATORIES; LAV-B:

- A. Lavatory: Solid surface bowl and counter provided and installed by G.C.
- B. Supply Faucet Manufacturers:
 - 1. Sloan Faucets: Model EFX-275-4-SOL-ISM-CP-0.5GPM-MLM-IR-FCT: www.sloan.com
 - 2. Chicago Faucets: www.chicagofaucets.com
 - 3. Moen, Inc: www.moen.com
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- C. Supply Faucet: ASME A112.18.1; Sensor operated Vandal resistant assembly. 4" Trim Plate, Solar Power Supply, Integrated Side Mixer, Polished Chrome Finish, 0.5 gpm, Multi-laminar Spray, Infrared Sensor, BASYS Solar-Powered (with battery back-up) Deck-Mounted Mid Body Faucet.
- D. Accessories:
 - 1. Anti-scalding point of use lead free adjustable thermostatic mixing valve to conform to NYS plumbing code 419.5 and ASSE 1070. Built -in check valve and low pressure drop.
 - a. Manufacturer: Watts. Model LFUSG-B M3
 - b. Substitutions: See Section 01 6000-Product Requirements.
 - 2. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
 - 3. Offset waste with perforated open strainer.
 - 4. Screwdriver stops.
 - 5. Flexible supplies.
 - 6. ADA pipe cover: Piping Safety Covers on all exposed traps and supply lines: Truebro Lav-Guard.

2.07 SINKS, SINK-A:

- A. Sink and Faucet supplied by others with casework.
- B. Accessories:
 - 1. Anti-scalding point of use lead free adjustable thermostatic mixing valve to conform to NYS plumbing code 419.5 and ASSE 1070. Built -in check valve and low pressure drop.
 - a. Manufacturer: Watts. Model LFUSG-B M3
 - b. Substitutions: See Section 01 6000-Product Requirements.
 - 2. Screwdriver stops.
 - 3. Flexible supplies.
 - 4. Dilution tanks (see 22 1006).
 - 5. Flat strainer.

2.08 SINKS, SINK-B:

- A. Sink and Faucet supplied by others with casework.
- B. Accessories:
 - 1. Cold water only (student tables).

2. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
3. Screwdriver stops.
4. Flexible supplies.
5. Dilution tanks (see 22 1006).
6. Flat stainer.

2.09 SINKS, SINK-C:

- A. Sink Manufacturers:
 1. American Standard, Inc.: www.americanstandard.com.
 2. Elkay Manufacturing Company: www.elkay.com.
 3. Just Manufacturing Company; Model DLADA-2128A55-J: www.justmfg.com.
 4. Kohler Company: www.kohler.com.
 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Double Compartment Bowl: ASME A112.19.3; 29 by 22 by 5.5 outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim with (3) hole centered. Rear center drain location. Bowls size: 11.5" wide x 16" x 5.5" deep.
- C. Supply Faucet:
 1. Manufacturers
 - a. Chicago Faucets: Model 786-GN10AE3SWGABCP: www.chicagofaucets.com
 - b. Just Manufacturing Company: www.justmfg.com
 - c. T&S Brass: www.tsbrass.com
 - d. Substitutions: See Section 01 6000 - Product Requirements.
 2. ASME A112.18.1;chrome plated cast brass concealed deck mounted 8" fixed centers, swing gooseneck 10" spout. 4" metal vandal-proof wrist blade handles. Quarter turn cartridge.
- D. Accessories:
 1. Anti-scalding point of use lead free adjustable thermostatic mixing valve to conform to NYS plumbing code 419.5 and ASSE 1070. Built -in check valve and low pressure drop.
 - a. Manufacturer: Watts. Model LFUSG-B M3
 - b. Substitutions: See Section01 6000-Product Requirements.
 2. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
 3. Screwdriver stops.
 4. Flexible supplies.
- E. Type 304 stainless steel crumb cup strainer, removable stainless steel basket, locking shell. 1-1/2inch O.D. 17 gauge chrome plated brass offset tailpiece system; Type 304 stainless tailpiece, 4 inch long.

2.10 SINKS, SINK-D:

- A. Sink Manufacturers:
 1. American Standard, Inc. www.americanstandard.com.
 2. Elkay Manufacturing Company: www.elkay.com.
 3. Just Manufacturing Company; Model SLADA2125A65-J: www.justmfg.com.
 4. Kohler Company: www.kohler.com.
 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Single Compartment Bowl: ASME A112.19.3; 25 by 21.25 by 6.5 outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim with (3) hole centered. Rear center drain location. Bowl size: 21" wide x 15.75" x 6.5" deep.
- C. Supply Faucet:
 1. Manufacturers:
 - a. Chicago Faucets: Model 786-GN10AE3SWGABCP: www.chicagofaucets.com
 - b. Just Manufacturing Company: www.justmfg.com
 - c. T&S Brass: www.tsbrass.com
 - d. Substitutions: See Section 01 6000 - Product Requirements.
 2. ASME A112.18.1;chrome plated cast brass concealed deck mounted 8" fixed centers, swing gooseneck 10" spout. 4" metal vandal-proof wrist blade handles. Quarter turn cartridge.

3. Accessories:
 - a. Anti-scalding point of use lead free adjustable thermostatic mixing valve to conform to NYS plumbing code 419.5 and ASSE 1070. Built -in check valve and low pressure drop.
 - 1) Manufacturer: Watts. Model LFUSG-B M3
 - 2) Substitutions: See Section 01 6000-Product Requirements.
 - b. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
 - c. Screwdriver stops.
 - d. Flexible supplies.
4. Type 304 stainless steel crumb cup strainer, removable stainless steel basket, locking shell. 1-1/2inch O.D. 17 gauge chrome plated brass offset tailpiece system; Type 304 stainless tailpiece, 4 inch long.

2.11 SINKS, SINK-E:

- A. Sink Manufacturers:
 1. American Standard, Inc.: www.americanstandard.com.
 2. Elkay Manufacturing Company: www.elkay.com.
 3. Just Manufacturing Company; Model SLXD2233A-J: www.justmfg.com.
 4. Kohler Company: www.kohler.com.
 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Single Compartment Bowl: ASME A112.19.3; 33 by 22 by 11-5/8 outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim. (3) hole centered. Rear center drain location. Bowl size: 28" wide x 16" x 11.5" deep.
- C. Supply Faucet:
 1. Manufacturers:
 - a. Chicago Faucets: Model 786-GN10AE3SWGABCP: www.chicagofaucets.com
 - b. Sloan Faucets: www.sloan.com
 - c. MOEN, Inc: www.moen.com
 - d. T&S Brass: www.tsbrass.com
 - e. Substitutions: See Section 01 6000 - Product Requirements.
 2. ASME A112.18.1; chrome plated cast brass concealed deck mounted 8" fixed centers, swing gooseneck 10" spout. 4" metal vandal-proof wrist blade handles. Quarter turn cartridge.
- D. Accessories:
 1. Anti-scalding point of use lead free adjustable thermostatic mixing valve to conform to NYS plumbing code 419.5 and ASSE 1070. Built -in check valve and low pressure drop.
 - a. Manufacturer: Watts. Model LFUSG-B M3
 - b. Substitutions: See Section 01 6000-Product Requirements.
 2. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
 3. Screwdriver stops.
 4. Flexible supplies.
 5. Offset tailpiece.
 6. Provide interceptors as described on drawings.
- E. Drain: stainless steel flat grid strainer model J-35-SSF by Just Manufacturing Company . 1-1/2inch O.D. 17 gauge chrome plated brass offset tailpiece system; Type 304 stainless tailpiece, 4 inch long.

2.12 SINKS, SINK-F:

- A. Sink Manufacturers:
 1. American Standard, Inc.: www.americanstandard.com.
 2. Elkay Manufacturing Company: www.elkay.com.
 3. Just Manufacturing Company; Model SLADA2233A60-J: www.justmfg.com.
 4. Kohler Company: www.kohler.com.
 5. Substitutions: See Section 01 6000 - Product Requirements.

- B. Single Compartment Bowl ADA compliant: ASME A112.19.3; 33 by 22 by 6 outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim. (3) hole centered. Rear center drain location. Bowl size: 28" wide x 16" x 6" deep.
- C. Supply Faucet:
 - 1. Manufacturers:
 - a. Chicago Faucets: Model 786-GN10AE3SWGABCP: www.chicagofaucets.com
 - b. Sloan Faucets: www.sloan.com
 - c. MOEN, Inc: www.moen.com
 - d. T&S Brass: www.tsbrass.com
 - e. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. ASME A112.18.1; chrome plated cast brass concealed deck mounted 8" fixed centers, swing gooseneck 10" spout. 4" metal vandal-proof wrist blade handles. Quarter turn cartridge.
- D. Accessories:
 - 1. Anti-scalding point of use lead free adjustable thermostatic mixing valve to conform to NYS plumbing code 419.5 and ASSE 1070. Built -in check valve and low pressure drop.
 - a. Manufacturer: Watts. Model LFUSG-B M3
 - b. Substitutions: See Section 01 6000-Product Requirements.
 - 2. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
 - 3. Screwdriver stops.
 - 4. Flexible supplies.
 - 5. Offset tailpiece.
 - 6. Provide interceptors as described on drawings.
- E. Drain: stainless steel flat grid strainer model J-35-SSF by Just Manufacturing Company . 1-1/2inch O.D. 17 gauge chrome plated brass offset tailpiece system; Type 304 stainless tailpiece, 4 inch long.

2.13 SINKS, SINK-G:

- A. Sink Manufacturers:
 - 1. American Standard, Inc. www.americanstandard.com.
 - 2. Elkay Manufacturing Company: www.elkay.com.
 - 3. Just Manufacturing Company; Model DL-2128A-J: www.justmfg.com.
 - 4. Kohler Company: www.kohler.com.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.
- B. Double Compartment Bowl: ASME A112.19.3; 29 by 22 by 7-5/8 outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim with (3) hole centered. Rear center drain location. Bowls size: 11.5" wide x 16" x 7.5" deep.
- C. Supply Faucet:
 - 1. Manufacturers:
 - a. Chicago Faucets: Model 786-GN10AE3SWGABCP: www.chicagofaucets.com
 - b. Just Manufacturing Company: www.justmfg.com
 - c. T&S Brass: www.tsbrass.com
 - d. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. ASME A112.18.1; chrome plated cast brass concealed deck mounted 8" fixed centers, swing gooseneck 10" spout. 4" metal vandal-proof wrist blade handles. Quarter turn cartridge.
 - 3. Accessories:
 - a. Anti-scalding point of use lead free adjustable thermostatic mixing valve to conform to NYS plumbing code 419.5 and ASSE 1070. Built -in check valve and low pressure drop.
 - 1) Manufacturer: Watts. Model LFUSG-B M3
 - 2) Substitutions: See Section 01 6000-Product Requirements.
 - b. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
 - c. Screwdriver stops.
 - d. Flexible supplies.

4. Type 304 stainless steel crumb cup strainer J-ADA-35 by Just Manufacturing Company, removable stainless steel basket, locking shell. 1-1/2inch O.D. 17 gauge chrome plated brass offset tailpiece system; Type 304 stainless tailpiece, 4 inch long.

2.14 ADA SHOWER, SH-A:

- A. Shower Drain: See section 22 1006 for Linear drain (LD-A) and FD-A description.
- B. Shower:
 1. Surface Mounted, ADA Compliant Wall Shower with fixed shower head and hand held. Shower panel shall be fabricated from 18 gage, type 304 stainless steel and shall have a satin finish. Exposed trim shall be chrome-plated brass. Fixture shall be furnished with an ADA compliant Control Valve with ADA Lever Handle and a surface mounted Soap Dish. Units to conform with ANSI, UFAS and ADA requirements for accessibility. Installation shall be made in accordance with manufacturer's recommendations and details.
 2. Manufacturers:
 - a. Acorn Engineering Company model 458BBF-W-LVR-MSH-F-2.0-D-LGB-HHGBC-1108CAP-1: acorneng.com.
 - b. Substitutions: See Section 01 6000 - Product Requirements.
 3. Provide unit with the following options:
 - a. Valve: The Thermostatic/Pressure Balancing Mixing Valve shall be ASSE 1016 compliant and delivers constant water flow by compensating for temperature and pressure fluctuations.
 - b. Reach: All Controls must be 38" to 48" from the finished floor to be within reach of a seated bather with limited arm movement.
 - c. Showerhead: Handheld Shower with On/Off Pushbutton, 60" Hose, Quick-Disconnect and 1.5 GPM Flow Control. Shower Panel has one fixed shower head at 6'.
 - d. Handheld shower to be mounted to a 24" grab bar slide rail.
- C. Two Wall Grab Bars:
 1. Constructed of 1-1/2" outer diameter type 304 stainless steel tubing with exposed surfaces polished to a satin finish and include 3" diameter wall flanges countersunk for furnished 2" long stainless steel vandal-resistant screws. Grab bars shall meet or exceed ANSI, UFAS, and ADA requirements for structural strength and have a 1-1/2" space between the grab bar and the mounting surface.
 2. Manufacturers:
 - a. Acorn Engineering Company; Model 1108-3: www.acorneng.com.
 - b. Or approved equal.
 - c. Substitutions: See Section 01 6000 - Product Requirements.
- D. Folding Seat:
 1. Seats shall fold effortlessly up against the wall or down into seating position. Frame shall be constructed of 1" Type 304 stainless steel tubing polished to a soft satin finish. Seats shall conform to ANSI, UFAS, and ADA requirements for accessibility.
 2. Phenolic seats shall be constructed of 1/2" x 3" water resistant phenolic slats with teak finish. Coordinate with contract drawings for correct orientation.
 3. Manufacturers:
 - a. Acorn Engineering Company; Model 1103-21, 1101-22: www.acorneng.com
 - b. Substitutions: See Section 01 6000 - Product Requirements.

2.15 ELECTRIC WATER COOLERS, EWC-A:

- A. Electric Water Cooler Manufacturers:
 1. Tri Palm International/Oasis: www.tripalmint.com.
 2. Elkay Manufacturing Company: www.elkay.com.
 3. Haws Corporation: www.hawesco.com.
 4. Substitutions: See Section 01 6000 - Product Requirements.

- B. Unit shall include electric water cooler with bottle filling station. LZS8WSLK shall deliver 8 GPH of 50 degree F drinking water at 90 degree F ambient and 80 degree F inlet water. Unit shall have pushbar activation. Bottle filling unit shall include an electronic sensor for touchless activation with auto 20-second shut-off timer. Shall include Green Ticker™ displaying count of plastic bottles saved from waste. Bottle filler shall provide 1.1-1.5 gpm flow rate with laminar flow to minimize splashing. Shall include integrated silver ion anti-microbial protection in key areas. Unit shall meet ADA guidelines. Unit shall be lead-free design which is certified to NSF/ANSI 61 and 372 and meets Federal and State low-lead requirements. Unit shall be certified to UL399 and CAN/CSA 22.2 No. 120.
- C. Provide water cooler with cane apron model LKAPREZL by Elkay.
- D. Water Cooler: Electric, mechanically refrigerated; single mounted; ADA compliant stainless steel top, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.
 - 1. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F minimum, when tested in accordance with ASHRAE Std 18.
 - 2. Electrical: 115 V, 60 Hertz single phase compressor.

2.16 ELECTRIC WATER COOLERS, EWC-B:

- A. Same as EWC-A but installed at same height as the unit it is replacing.

2.17 EMERGENCY STATION, EWS-A:

- A. Provided and installed by G.C. Plumbing contractor to make all piping connections.
- B. Mixing valve (provided and installed by P.C.):
 - 1. Manufacturers:
 - a. Guardian Equipment; Model G6040: www.gesafety.com
 - b. Bradley Corporation: www.bradleycorp.com.
 - c. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. thermostatic mixing valve precisely blends hot and cold water to deliver warm (tepid) water as provided by ANSI Z358.1-2014.
 - 3. Mount unit inside base cabinet of fume hood.
- C. G6040 thermostatic mixing valve precisely blends hot and cold water to deliver warm (tepid) water as provided by ANSI Z358.1-2014.

2.18 PIPING INSULATION ACCESSORIES:

- A. Provide products that comply with the following:
 - 1. Americans With Disabilities Act (ADA), Article 4.19.4.
- B. Piping Safety Covers on all exposed traps: Truebro Lav-Guard.
 - 1. Characteristics: Three-piece molded assembly, minimum 1/8 inch wall thickness, with internal ribs to provide air space between piping and piping insulation jacket, molded to receive manufacturer's snap-clip fasteners.
 - 2. Vinyl Material: Impact-resistant and stain-resistant molded closed-cell anti-microbial vinyl compound, UV-stable, non-fading, non yellowing; having the following performance characteristics:
 - a. Burning Characteristics: 0 seconds Average Time of Burning (ATB), 0 mm Area of Burning (AEB), when tested in accordance with ASTM D 635.
 - b. Thermal Conductivity: K-value 1.17, when tested in accordance with ASTM C 177.
 - c. Indentation Hardness: 60, minimum, when tested in accordance with ASTM D 2240, using Type A durometer.
 - 3. Trap Assembly Cover: Three-piece assembly, with removable clean-out nut enclosure.
 - 4. Angle Stop Covers: Formed with hinged cap for access to valve without requiring cover removal.
 - 5. Configurations: In accordance with manufacturer's product data for project piping configurations indicated on drawings.
 - 6. Color: China White, gloss finish; paintable.
 - 7. Fasteners: Manufacturer's standard re-usable snap-clip fasteners; wire-tie fasteners not permitted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.

3.02 PREPARATION

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

3.03 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall carriers and bolts.
- E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 9200 - Joint Sealants; color to match fixture.
- F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

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

3.05 ADJUSTING

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

3.06 CLEANING

- A. Clean plumbing fixtures and equipment.

3.07 PROTECTION

- A. Protect installed products from damage due to subsequent construction operations.
- B. Do not permit use of fixtures by construction personnel.
- C. Repair or replace damaged products before Date of Substantial Completion.

3.08 SCHEDULES

- A. Fixture Heights: Install fixtures to heights above finished floor as indicated.
 - 1. Water Closet Flush Valves:
 - a. Standard: 11 inches min. above bowl rim.
 - 2. Urinal:
 - a. Standard: 22 inches to top of bowl rim.
 - b. Accessible: 17 inches to top of bowl rim.
 - 3. Lavatory:
 - a. Accessible: 34 inches to top of basin rim.
 - 4. Drinking Fountain/Water Cooler:
 - a. Standard Adult: 40 inches to top of basin rim.
 - b. Accessible: 36 inches to top of spout.
 - 5. Emergency Eye and Face Wash:
 - a. Standard: 38 inches to receptor rim.
- B. Fixture Rough-In
 - 1. Water Closet (Flush Valve Type):
 - a. Cold Water: 1 Inch.
 - b. Waste: 4 Inch.
 - c. Vent: 2 Inch.

2. Urinal (Flush Valve Type):
 - a. Cold Water: 3/4 Inch.
 - b. Waste: 2 Inch.
 - c. Vent: 1-1/2 Inch.
3. Lavatory:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/4 inch.
 - d. Vent: 1-1/4 Inch.
4. Sink:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 Inch.
 - d. Vent: 1-1/2 inch.
5. Service Sink:
 - a. Hot Water: 3/4 inch.
 - b. Cold Water: 3/4 inch.
 - c. Waste: 2 Inch.
 - d. Vent: 1-1/2 Inch.
6. Drinking Fountain / Water Cooler:
 - a. Cold Water: 1/2 Inch.
 - b. Waste: 1-1/2 inch.
 - c. Vent: 1-1/4 Inch.
7. Shower:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 2 inch.

END OF SECTION

**SECTION 23 0510
BASIC MECHANICAL REQUIREMENTS**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, tools, materials, accessories, parts, transportation, taxes, and related items, essential for installation of the work and necessary to make work complete and operational. Provide new equipment and material unless otherwise called for. References to codes, specifications, and standards called for in the specification sections and on the drawings mean the latest edition, amendment, and revision of such referenced standard in effect on the date of these contract documents.

1.02 LICENSING

- A. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
- B. The Contractor shall be responsible for reviewing the local jurisdiction requirements prior to bidding.

1.03 PERMITS

- A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges.

1.04 CODE COMPLIANCE

- A. Provide work in compliance with the following:
 - 1. The Building Code of New York State including The Fire Code; Property Maintenance Code; Plumbing Code, Mechanical Code and Fuel Gas Code; and The Energy Code of New York.
 - 2. New York State Department of Labor Rules and Regulations.
 - 3. Occupational Safety and Health Administration (OSHA).
 - 4. National Fuel Gas Code, NFPA 54.
 - 5. National Electrical Code, NFPA 70.
 - 6. Local Codes and Ordinances.
 - 7. Life Safety Codes, NFPA 101 (2003).
 - 8. New York Board of Fire Underwriters.
 - 9. New York State Education Department "Manual of Planning Standards".
 - 10. Part 4 of Title 12 Rules and Regulations of the State of New York Industrial Code Rule No. 4 (12NYCRR4).

1.05 GLOSSARY

- A. AGA American Gas Association
- B. AIA American Institute of Architects
- C. AFBMA Anti-Friction Bearing Manufacturer's Association
- D. AMCA Air Moving and Conditioning Association, Inc.
- E. ANSI American National Standards Institute
- F. ARI Air Conditioning and Refrigeration Institute
- G. ASHRAE American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.
- H. ASME American Society of Mechanical Engineers
- I. ASPE American Society of Plumbing Engineers
- J. ASTM American Society for Testing Materials
- K. IBR Institute of Boiler & Radiation Manufacturers
- L. IEEE Institute of Electrical and Electronics Engineers
- M. NYBFU New York Board of Fire Underwriters
- N. NEC National Electrical Code
- O. NEMA National Electrical Manufacturer's Association

- P. NESC National Electrical Safety Code
- Q. NFPA National Fire Protection Association
- R. NYS/DEC New York State Department of Environmental Conservation
- S. SMACNA Sheet Metal and Air Conditioning Contractors National Association
- T. UFPO Underground Facilities Protective Organization
- U. UL Underwriter's Laboratories, Inc.
- V. OSHA Occupational Safety and Health Administration
- W. NYS/UFPC New York State Uniform Fire Prevention and Building Code

1.06 DEFINITIONS

- A. Acceptance: Owner acceptance of the project from Contractor upon certification by Owner's Representative.
- B. Approval/approved written permission to use a material or system.
- C. As Called for Materials: Equipment including the execution specified/shown in the contract documents.
- D. Code requirements: Minimum requirements.
- E. Concealed Work: Installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
- F. Design Equipment: Refer to the article, Equipment Arrangements, and the article, Substitutions.
- G. Design Make: Refer to the articles, Equipment Arrangements, and the article, Substitutions.
- H. Exposed Work not identified as concealed.
- I. Equal or Equivalent: Equally acceptable as determined by Owner's Representative.
- J. Furnish: Supply and deliver to installed location.
- K. Furnished by Others: Receive delivery at job site or where called for and install.
- L. Inspection: Visual observations by Owner's Site Representative.
- M. Install: Mount and connect equipment and associated materials ready for use.
- N. Labeled Refers to classification by a standards agency.
- O. Make: Refers to the article, Equipment Arrangements, and the article, Substitutions.
- P. Or Approved Equal: Approved equal or equivalent as determined by Owner's Representative.
- Q. Owner's Representative: The Prime Professional.
- R. Prime Professional: Architect or Engineer having a contract directly with the Owner for professional services.
- S. Provide: Furnish, install, and connect ready for use.
- T. Relocate: Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
- U. Replace: Remove and provide new item.
- V. Review: A general contractual conformance check of specified products.
- W. Roughing: Pipe, duct, conduit, equipment layout and installation.
- X. Satisfactory: As specified in contract documents.
- Y. Site Representative: Owner's inspector or "Clerk of Works" at the work site.

1.07 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the Drawings and specifications. The Contractor is responsible for: confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.
- B. See Specification Section 01 3000 - Administrative Requirements for submittal procedures.

1.08 PROTECTION OF PERSONS AND PROPERTY

- A. Contractor shall assume responsibility for construction safety at all times and provide as part of Contract all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety features required to provide safe conditions for all workmen and site visitors.

1.09 EQUIPMENT ARRANGEMENTS

- A. The Contract Documents are prepared on basis of one (1) manufacturer as "design equipment," even though other manufacturer's names are listed as acceptable makes. If Contractor elects to use one (1) of the listed makes other than "design equipment," submit detailed Drawings, indicating proposed installation of equipment. Show maintenance arrangement. Make required changes in the Work of other trades, at no increase in any Contract. Provide larger motors, feeders, breakers, and equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings, or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to Contract Documents.

1.10 CONTINUITY OF SERVICES

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of Contract Work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical facilities or associated services.

1.11 ROUGHING

- A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, interferences, etc. Make necessary changes in Contract Work, equipment locations, etc., as part of a Contract to accommodate Work to obstacles and interferences encountered. Before installing, verify exact location and elevations at work site. DO NOT SCALE plans. If field conditions, details, changes in equipment or Shop Drawing information require an important rearrangement, report same to Owner's Representative for review. Obtain written approval for all major changes before installing.

- B. Install work so that items both existing and new are operable and serviceable. Eliminate interference with removal of coils, motors, filters, belt guards and/or operation of doors. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Where Contractor could not reasonably be expected to find such trade interferences due to concealment in walls, ceiling or floors, such relocations will be done by Change Order, if not, included in Contract Work. Contractor shall relocate existing work in way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK SINCE FEW OF SUCH ITEMS CAN BE SHOWN. Provide new materials, including new piping and insulation for relocated work.
- C. Coordinate Work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas (i.e., thermostat, fixture, and switch mounting heights, and equipment mounting heights). Coordinate all Work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical Drawings show design arrangement only for diffusers, grilles, registers, air terminals, and other items. Do not rough-in Contract Work without reflected ceiling location plans.
- D. Before roughing for equipment furnished by Owner or in other Contracts, obtain from Owner and other Contractors, approved Roughing Drawings giving exact location for each piece of equipment. Do not "rough in" services without Final Layout Drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. For equipment and connections provided in this Contract, prepare Roughing Drawing as follows:
 - 1. Existing equipment: Measure the existing equipment and prepare for installation in new location.
 - 2. New equipment: Obtain equipment roughing drawings and dimensions, then prepare roughing-in-drawings. If such information is not available in time, obtain an acknowledgement in writing, then make space arrangements as required with Owner's Representative.

1.12 REMOVAL WORK

- A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State, and Local law requirements. Where equipment is called for to be relocated, Contractor shall carefully remove, clean and recondition, then re-install. Removal all abandoned piping, equipment, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl space, and roof to determine the total Scope of Work. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

1.13 EQUIPMENT AND MATERIAL INSTALLATION

- A. Provide materials that meet the following minimum requirements:
 - 1. Materials shall have a flame spread rating of 25 or less and smoke developed rating of 50 or less, in accordance with NFPA 255.
 - 2. All equipment and material for which there is a listing service shall bear a UL label.
 - 3. Gas-fired equipment and system shall meet AGA Regulations and shall have AGA label.
 - 4. Mechanical and electrical equipment and systems with electrical components shall be UL Listed and meet UL Standards and requirements of the NEC.

1.14 CUTTING AND PATCHING

- A. Mechanical trade shall include their required cutting and patching work unless shown as part of the General Construction Work on the Architectural Drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch any cut or abandoned holes left by removals of equipment, fixtures, etc. Patch adjacent existing Work disturbed by installation of new Work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

1.15 PAINTING

- A. Include painting for patchwork with color to match adjacent surfaces. Where color cannot be adequately matched, paint entire surface. Provide one (1) coat of primer and two (2) finish coats. Refer to General Construction Specifications for additional information.

1.16 CONCEALMENT

- A. Conceal all Contract Work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the Work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

1.17 CHASES

- A. New Construction:
 - 1. Certain chases, recessed, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical Trade Work shall provide all other openings required for their Contract Work.
 - 2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction Work.
 - 3. Assume responsibility for correct and final location and size of such openings.
 - 4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.
 - 5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2 inches above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all Work and equipment damaged during course of drilling. Firestop all unused sleeves.
 - 6. Provide angle iron frame where openings are required for Contract Work, unless provided by General Contractor.
- B. In Existing Buildings:
 - 1. Drill holes for floor and/or roof slab openings.
 - 2. Multiple Pipes Smaller than 1 Inch: Properly spaced and supported may pass through one (1) 6 inch or smaller diameter opening.
 - 3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2 inches above floors.
 - 4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

1.18 FLASHING, SEALING, FIRE-STOPPING

- A. See Specification Section 07 8400 - Firestopping.

1.19 SUPPORTS

- A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support Contract Work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit Contract Work. If necessary in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support Mechanical/Electrical Work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting Contract Work. Mounting plates shall span two (2) or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

1.20 ACCESS PANELS

- A. Access panels shall be furnished by the Mechanical Trade and installed by General Contractor. Location and size shall be the responsibility of Mechanical Trade. Bear cost of construction changes necessary due to improper information or failure to provide proper information in ample time. Access panels over 324 square inches shall have two (2) cam locks. Contractor shall provide proper frame and door type for various wall or ceiling finishes. Access panels shall be equal to "Milcor" as manufactured by Inland Steel Products Co., Milwaukee, Wisconsin. Provide General Contractor with a set of architectural black and white prints with size and approximate locations of access panels shown.

1.21 CONCRETE BASES

- A. Provide concrete bases for all floor-mounted equipment (unless otherwise noted). Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 inches high (unless otherwise indicated); shape and size to accommodate equipment. Set anchor bolts in sleeves before pouring and after anchoring and leveling, fill equipment bases with grout.

1.22 HVAC EQUIPMENT CONNECTIONS

- A. Mechanical Contractor is responsible for draining, filling, venting, chemically treating and restarting any systems which are affected by work shown on the Contract Documents unless specifically noted otherwise.
- B. Provide final hydronic, steam, drain, vent, and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and rail connections extended to floor drains.
- C. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, as required.
- D. Refer to manufacturer drawings and specifications for requirements of kitchen equipment, laboratory equipment and special equipment. Verify connection requirements before bidding.

1.23 DELIVERY

- A. Accept materials delivered on site in manufacturer's packaging, labeled with manufacturer's identification and product information.

1.24 STORAGE AND PROTECTION OF MATERIALS

- A. Store materials on dry base, at least 6 inches above ground or floor. Store so as not to interfere with other Work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
- B. Maintain ambient conditions for each product as required by each manufacturer from time of delivery. Maintain appropriate ambient conditions for installation as recommended by each manufacturer for a minimum of 24 hours prior and 24 hours after installation.
- C. Refer to "General Conditions of the Contract for Construction."

1.25 FREEZING AND WATER DAMAGE

- A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no charge in contract, any such damage to equipment, systems, and building. Perform first seasons winterizing in presence of Owner's operating staff.

1.26 LUBRICATION CHART

- A. Provide lubrication chart, 8-1/2 inch x 11 inch minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall in area of equipment. List all motors and equipment in contract. Obtain and list necessary information by name/location of equipment, manufacturer recommended types of lubrication and schedule. Lubricate motors as soon as installed and perform lubrication maintenance until final acceptance. Plumbing trade shall add contract items to the chart provided by the heating trade or provide separate charts.

1.27 OWNER INSTRUCTIONS

- A. Before final acceptance of the Work, furnish necessary skilled labor to operate all systems by seasons. Instruct designated person on proper operation and care of systems/equipment. Repeat instructions, if necessary. Obtain written acknowledgement from person instructed prior to final payment. Contractor is fully responsible for system until final acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. List under clear plastic, operating, maintenance, and starting precautions procedures to be followed by Owner for operating systems and equipment.

1.28 MAINTENANCE MANUALS

- A. Prepare Instructions and Maintenance Portfolios. Include one (1) copy of each of approved Shop Drawing, wiring diagram, piping diagram spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, summer-winter changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer representative and service agency for all major equipment items in a 3-ring binder with name of project on the cover. Deliver to Owner's Representative before request for final acceptance.

1.29 RECORD DRAWINGS

- A. The Contractor shall obtain at his expense one (1) set of construction Contract Drawings including non-reproducible black and white prints and one (1) set of reproducible mylars for the purpose of recording record conditions.
- B. The Contractor shall perform all survey work required for the location and construction of the work and to record information necessary for completion of the Record Drawings. Record Drawings shall show the actual location of the constructed facilities in the same manner as was shown on the Bid Drawings. All elevations and dimensions shown on the Drawings shall be verified or corrected so as to provide a complete and accurate record of the facilities as constructed.
- C. It shall be the responsibility of the Contractor to mark each sheet of the non-reproducible drawings in pencil and to record thereon in a legible manner, any and all approved field changes and conditions as they occur. A complete file of approved field sketches, diagrams, and other changes shall also be maintained. At completion of the work, each sheet of record prints, plus all approved field sketches and diagrams shall be used in preparation of the mylar reproducible record drawings.
- D. Completed reproducible mylar Drawings shall be certified as reflecting record conditions and submitted to the Engineer for approval.

1.30 ADDITIONAL ENGINEERING SERVICES

- A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any monies owed to the Contractor.

1.31 FINAL INSPECTION

- A. Upon completion of all punch list items, the Contractor shall provide a copy of the punch list back to the Architect/Engineer with each item noted as completed or the current status of the item. Upon receipt, the Architect/Engineer will schedule a final inspection.

1.32 ALL TRADES TEMPORARY HEAT

- A. Refer to the General Conditions of the Contract for Construction and Supplementary Conditions of the Contract for Construction.

1.33 HVAC MAINTENANCE OF SYSTEMS DURING TEMPORARY USE PERIODS

- A. Provide each air handling system with a set of prefilters in addition to the permanent filters. Furnish four (4) sets of prefilters for each system for use when system is operated for temporary heating or cooling. During such use, change prefilters as often as directed by Owner's Representative. Provide necessary temporary throw away filters in all return openings to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply units only. Do not operate return fans.
- B. Blank-off outside air intake opening during temporary heating period. Install first set of permanent filters and prefilters.
- C. Adjust dampers on supply system.
- D. Set all heating coil control valves for manual operation.
- E. Do not install any grilles or diffusers at room terminal ends of ducts until permission is given.
- F. Assume responsibility for systems and equipment at all times, even though used for temporary heat or ventilating. Repair or replace all dented, scratched or damaged parts of systems prior to final acceptance.
- G. Remove concrete, rust, paint spots, other blemishes, then clean.
- H. Just prior to final acceptance, remove used final filter. Deliver all unused sets of prefilters to the Owner and obtain written receipt. Properly lubricate system bearings before and during temporary use. Maintain thermostats, freeze stats, overload devices, and all other safety controls in operating condition.

1.34 CLEANING

- A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this Contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises after all tests are made and installations completed satisfactorily:
- B. Thoroughly clean entire installation, both exposed surfaces and interiors.
- C. Remove all debris caused by work.
- D. Remove tools, surplus, materials, when work is finally accepted.

1.35 SYSTEM START-UP AND TESTING

- A. All new heating and ventilating shall be started up and operated at normal operating temperature for a period of 24 hours to "bake-off" the equipment. The associated ventilation system shall run on 100 percent outside air during the bake-off for an additional 8 hours to purge the building. This Work shall be completed prior to building occupancy or if the Work is not completed in time for summer "bake-off" on a Saturday with the Contractor responsible for being on-site during the entire purge and bake-off operation.
- B. Work of any Contract which includes system "bake-off", system start-up, system cut-over or staff training shall not be done 1 week prior to and 1 week after the opening of the building/addition except upon written approval by the Owner.

- C. Start-up of testing of HVAC systems shall occur while the building is not occupied by Owner and only after notice to the Project Inspector is made at least 24 hours in advance. The Mechanical Contractor shall be responsible for providing temporary filter media over all supply air registers and diffusers during the HVAC system start-up procedure. The Mechanical Contractor shall provide airtight plastic covers over all supply and return air openings prior to the start of construction by any Contractor. The plastic shall be maintained airtight throughout the project construction and removed only with the approval of the Project Inspector.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 23 0517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe sleeves.
- B. Manufactured sleeve-seal systems.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment: Piping identification.
- C. Section 23 0719 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
- B. Pipe Passing Through Exterior Walls:
 - 1. Zinc coated or cast iron pipe with asphalt coating.
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- C. Pipe Passing Through Mechanical Floors and walls:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1-1/2 inch greater than external; pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
 - 1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com/#sle.
 - 2. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
- B. Modular/Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.

2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Structural Considerations:
 1. Do not penetrate building structural members unless indicated.
- E. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 1. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 2. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
 3. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- F. Manufactured Sleeve-Seal Systems:
 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 3. Locate piping in center of sleeve or penetration.
 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 5. Tighten bolting for a water-tight seal.
 6. Install in accordance with manufacturer's recommendations.
- G. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Applications.
- B. General requirements.
- C. Ball valves.
- D. Butterfly valves.
- E. Check valves.
- F. Chainwheels.
- G. Drain valves.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 23 0719 - HVAC Piping Insulation.
- D. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B31.9 - Building Services Piping.
- D. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- E. ASTM A536 - Standard Specification for Ductile Iron Castings.
- F. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
- G. AWWA C606 - Grooved and Shouldered Joints.
- H. MSS SP-45 - Drain and Bypass Connections.
- I. MSS SP-67 - Butterfly Valves.
- J. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends.
- K. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.
- L. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves.
- M. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.05 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 2. Protect valve parts exposed to piped medium against rust and corrosion.
 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 4. Secure check valves in either the closed position or open position.
 5. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Provide the following valves for the applications indicated:
1. Isolation (Shutoff): Butterfly and Ball.
 - a. 2-1/2 NPS and smaller: Bronze Ball Valve.
 - b. 3 NPS and larger: Iron Ball or Butterfly Valve.
 2. Check Valves:
 - a. 2-1/2 NPS and Smaller: Bronze Swing Check Valve.
 - b. 3 NPS and Larger: Iron Swing Check Valve.
 3. Low Point Drains:
 - a. All Sizes: 3/4 NPS Bronze Drain Valve with Cap.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
 2. Handwheel: Valves other than quarter-turn types.
 3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- D. Valves in Insulated Piping: Provide 2 NPS stem extensions and the following features:
1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 2. Butterfly Valves: Extended neck.
 3. Memory Stops: Fully adjustable after insulation is installed.
- E. Memory Stops: Fully adjustable after insulation is installed.
- F. Valve-End Connections:
1. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 2. Solder Joint Connections: ASME B16.18.
 3. Mechanical Press: ASME B16.51
 4. Grooved End Connections: AWWA C606.
- G. General ASME Compliance:
1. Building Services Piping Valves: ASME B31.9.
- H. Bronze Valves:
1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.

- I. Valve Bypass and Drain Connections: MSS SP-45.
- J. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE BALL VALVES

- A. Two Piece, Full Port with Bronze or Brass Trim:
 - 1. Comply with MSS SP-110.
 - 2. CWP Rating: 600 psig.
 - 3. Body: Bronze.
 - 4. Ends: Threaded or Mechanical Press
 - 5. Seats: PTFE or RPTFE.
 - 6. Stem: Extended Brass.
 - 7. Ball: Chrome plated brass.
 - 8. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.

2.04 IRON, GROOVED-END BALL VALVES

- A. Class 200:
 - 1. CWP Rating: 600 psig.
 - 2. Body: Ductile iron; ASTM A395.
 - 3. Ends: Grooved.
 - 4. Seats: PTFE.
 - 5. Stem: Type 316 Stainless steel.
 - 6. Ball: Type 316 Stainless Steel.
 - 7. Manufacturers:
 - a. Victaulic Series 726: www.victaulic.com

2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type: Bi-directional dead end service without downstream flange.
 - 1. Comply with MSS SP-67, Type I.
 - 2. CWP Rating: 200 psig.
 - 3. Body Material: ASTM A536 ductile iron.
 - 4. Stem: One or two-piece stainless steel.
 - 5. Seat: EPDM.
 - 6. Disc: Aluminum-bronze.
 - 7. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.

2.06 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 300 psig (2070 kPa): 8 NPS (50 DN) or smaller.
 - 1. Comply with MSS SP-67, Type I.
 - 2. Body: ASTM A536 Ductile Iron.
 - 3. Stem: Stainless steel.
 - 4. Disc: Aluminum Bronze.
 - 5. Disc Seal: EPDM.
 - 6. Manufacturers:
 - a. Victaulic Series 761: www.victaulic.com

2.07 BRONZE LIFT CHECK VALVES

- A. Class 125:
 - 1. CWP Rating: 400 psig.
 - 2. Design: Horizontal or Vertical flow.
 - 3. Body: Bronze.
 - 4. Ends: Threaded.
 - 5. Disc: RPTFE Ball Cone Check.

6. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.

2.08 BRONZE SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa).
 1. Comply with MSS SP-80, Type 3.
 2. Body Design: Horizontal flow.
 3. Body Material: Bronze, ASTM B62.
 4. Ends: Threaded.
 5. Disc: Bronze.
 6. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com.

2.09 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa) with Metal Seats.
 1. Comply with MSS SP-71, Type I.
 2. Design: Clear or full waterway with flanged ends.
 3. Body: Gray iron with bolted bonnet in accordance with ASTM A126.
 4. Trim: Bronze.
 5. Disc Holder: Bronze.
 6. Disc: ASTM A126 Cast Iron.
- B. Manufacturers:
 1. Apollo Valves: www.apollovalves.com.

2.10 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP:
 1. 2 NPS to 8 NPS.
 2. 10 NPS to 12 NPS.
 3. CWP Rating: 300 psig.
 4. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
 5. Disc: Stainless steel.
 6. Coating: Black, non-lead paint.
 7. Seat: EPDM.
 8. Serviceable closure housing with removable cap.
 9. Manufacturers:
 - a. Victaulic Series 712: www.victaulic.com.

2.11 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 2. Attachment: For connection to butterfly valve stems.
 3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
 4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

2.12 DRAIN VALVE

- A. Two Piece, Full Port with Bronze or Brass Trim:
 1. Comply with MSS SP-110.
 2. CWP Rating: 300 psig.
 3. Body: Bronze.
 4. Ends: Threaded or Mechanical Press
 5. 3/4" Hose Connection with heavy brass cap with heavy duty stainless steel chain.
 6. Seats: Multi-fill PTFE.
 7. Stem: Brass ASTMB16.
 8. Ball: Chrome plated brass.
 9. Manufacturers:

- a. Apollo Valves: www.apollovalves.com.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Provide chainwheels on operators for valves 4 NPS and larger where located 8 feet or more above finished floor, terminating 6 feet above finished floor.

END OF SECTION

SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- I. MFMA-4 - Metal Framing Standards Publication.
- J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.06 QUALITY ASSURANCE

- A. Comply with applicable building code.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 3. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Comply with MFMA-4.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
 - 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
 - c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- D. Thermal Insulated Pipe Supports:
 - 1. General Construction and Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.

2. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Thickness: 60 mil.
 3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.
- E. Pipe Supports:
1. Liquid Temperatures Up To 122 degrees F:
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
- F. Pipe Stanchions: For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- G. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- H. Riser Clamps:
1. Provide copper plated clamps for copper tubing support.
 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- I. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- J. Strut Clamps: Two-piece pipe clamp.
- K. Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- L. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- M. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
- N. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
1. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- O. Pipe Shields for Insulated Piping:
1. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- P. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners are not permitted.
11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G. Equipment Support and Attachment:
 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners according to manufacturer's recommended torque settings.
- J. Remove temporary supports.

END OF SECTION

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.

1.02 RELATED REQUIREMENTS

- A. Section 09 9123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Control Panels: Nameplates.
- D. Dampers: Ceiling tacks, where located above lay-in ceiling.
- E. Ductwork: Nameplates.
- F. Heat Transfer Equipment: Nameplates.
- G. Piping: Tags.
- H. Pumps: Nameplates.
- I. Tanks: Nameplates.
- J. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- K. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
- B. Letter Color: White.
- C. Letter Height: 1/4 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Manufacturers:

1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 3. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual Label.
- C. Color: Yellow/Black.

2.05 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
- B. Stencil Paint: As specified in Section 09 9123, semi-gloss enamel, colors complying with ASME A13.1.

2.06 PIPE MARKERS

- A. Manufacturers:
1. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 2. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Color code as follows:
1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2.07 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
1. HVAC Equipment: Yellow.
 2. Fire Dampers and Smoke Dampers: Red.
 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 9123 for stencil painting.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 09 9123.

- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Use tags on piping 3/4 inch diameter and larger.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- H. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Commissioning activities.

1.02 RELATED REQUIREMENTS

- A. Section 01 9113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- B. Section 23 0800 - Commissioning of HVAC.

1.03 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- C. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.
 - e. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.

2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. TAB Agency Qualifications:
1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

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

3.03 PREPARATION

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

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

- E. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 COMMISSIONING

- A. See Sections 01 9113 - General Commissioning Requirements and 23 0800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 20 percent of the air handlers plus a random sample equivalent to 10 percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.

3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F.
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.09 SCOPE

- A. Test, adjust, and balance the following:
1. Plumbing Pumps.
 2. HVAC Pumps.
 3. Packaged Steel Fire Tube Boilers.
 4. Air Cooled Water Chillers.
 5. Packaged Roof Top Heating/Cooling Units.
 6. Computer Room Air Conditioning Units.
 7. Air Coils.
 8. Terminal Heat Transfer Units.
 9. Induction Units.
 10. Air Handling Units.
 11. Fans.
 12. Air Filters.
 13. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
1. Manufacturer.
 2. Model/Frame.
 3. HP/BHP.
 4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.

8. Sheave Make/Size/Bore.
- B. Pumps:
1. Identification/number.
 2. Manufacturer.
 3. Size/model.
 4. Impeller.
 5. Service.
 6. Design flow rate, pressure drop, BHP.
 7. Actual flow rate, pressure drop, BHP.
 8. Discharge pressure.
 9. Suction pressure.
 10. Total operating head pressure.
 11. Shut off, discharge and suction pressures.
 12. Shut off, total head pressure.
- C. Combustion Equipment:
1. Boiler manufacturer.
 2. Model number.
 3. Serial number.
 4. Firing rate.
 5. Overfire draft.
 6. Gas pressure at meter outlet.
 7. Gas flow rate.
 8. Heat input.
 9. Burner manifold gas pressure.
 10. Percent carbon monoxide (CO).
 11. Percent carbon dioxide (CO₂).
 12. Percent oxygen (O₂).
 13. Percent excess air.
 14. Flue gas temperature at outlet.
 15. Ambient temperature.
 16. Net stack temperature.
 17. Percent stack loss.
 18. Percent combustion efficiency.
 19. Heat output.
- D. Chillers:
1. Identification/number.
 2. Manufacturer.
 3. Capacity.
 4. Model number.
 5. Serial number.
 6. Evaporator entering water temperature, design and actual.
 7. Evaporator leaving water temperature, design and actual.
 8. Evaporator pressure drop, design and actual.
 9. Evaporator water flow rate, design and actual.
- E. Cooling Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Entering air DB temperature, design and actual.
 7. Entering air WB temperature, design and actual.

8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Water flow, design and actual.
 11. Water pressure drop, design and actual.
 12. Entering water temperature, design and actual.
 13. Leaving water temperature, design and actual.
 14. Air pressure drop, design and actual.
- F. Heating Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- G. Induction Units:
1. Manufacturer.
 2. Identification/number.
 3. Location.
 4. Model number.
 5. Size.
 6. Design air flow.
 7. Design nozzle pressure drop.
 8. Final nozzle pressure drop.
 9. Final air flow.
- H. Air Moving Equipment:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Arrangement/Class/Discharge.
 6. Air flow, specified and actual.
 7. Return air flow, specified and actual.
 8. Outside air flow, specified and actual.
 9. Total static pressure (total external), specified and actual.
 10. Inlet pressure.
 11. Discharge pressure.
 12. Sheave Make/Size/Bore.
 13. Number of Belts/Make/Size.
 14. Fan RPM.
- I. Return Air/Outside Air:
1. Identification/location.
 2. Design air flow.
 3. Actual air flow.
 4. Design return air flow.
 5. Actual return air flow.
 6. Design outside air flow.

7. Actual outside air flow.
 8. Return air temperature.
 9. Outside air temperature.
 10. Required mixed air temperature.
 11. Actual mixed air temperature.
 12. Design outside/return air ratio.
 13. Actual outside/return air ratio.
- J. Exhaust Fans:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Air flow, specified and actual.
 6. Total static pressure (total external), specified and actual.
 7. Inlet pressure.
 8. Discharge pressure.
 9. Sheave Make/Size/Bore.
 10. Number of Belts/Make/Size.
 11. Fan RPM.
- K. Duct Traverses:
1. System zone/branch.
 2. Duct size.
 3. Area.
 4. Design velocity.
 5. Design air flow.
 6. Test velocity.
 7. Test air flow.
 8. Duct static pressure.
 9. Air temperature.
 10. Air correction factor.
- L. Duct Leak Tests:
1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.
 8. Test orifice differential pressure.
 9. Leakage.
- M. Terminal Unit Data:
1. Manufacturer.
 2. Type, constant, variable, single, dual duct.
 3. Identification/number.
 4. Location.
 5. Model number.
 6. Size.
 7. Minimum static pressure.

8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.

END OF SECTION

**SECTION 23 0713
DUCT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 23 0553 - Identification for HVAC Piping and Equipment.
- B. Section 23 3100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- C. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- E. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.

3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 1200 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent.
 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
1. Aeroflex USA, Inc: www.aeroflexusa.com/#sle.
 2. Armacell LLC: www.armacell.us/#sle.
 3. K-Flex USA LLC: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
1. Minimum Service Temperature: Minus 40 degrees F.
 2. Maximum Service Temperature: 180 degrees F.
 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.05 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

2.06 DUCT LINER

- A. Manufacturers:
1. Armacell LLC: www.armacell.us/#sle.
 2. CertainTeed Corporation: www.certainteed.com/#sle.
 3. Johns Manville: www.jm.com/#sle.
 4. Knauf Insulation: www.knaufinsulation.com/#sle.

- B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Fungal Resistance: No growth when tested according to ASTM G21.
 - 4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.40.
 - 6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm per ASTM C1071.
 - 7. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.
- D. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; rigid board and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
 - 1. Fungal Resistance: No growth when tested according to ASTM G21.
 - 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 - 3. Service Temperature: Up to 250 degrees F.
 - 4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.45.
- E. Adhesive: Waterproof, fire-retardant type, ASTM C916.
- F. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- E. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

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

3.03 SCHEDULES

- A. Exhaust Ducts within 10 Feet of Exterior Openings:
 - 1. Flexible Blanket: Ducts up to 18" wide.
 - a. Minimum Thickness: 2 inch.
 - b. Minimum R value: R-6.
 - c. Jacket Type: Vapor Barrier.
 - 2. Rigid Board: Ducts over 18" wide.
 - a. Minimum Thickness: 1-1/2 inches.
 - b. Minimum R value: R-6.
 - c. Jacket Type: Vapor Barrier.
- B. 100% Outside Air Ducts:
 - 1. Concealed inside building envelope in unconditioned spaces:
 - a. Flexible Blanket: Ducts up to 18" wide.
 - 1) Minimum Thickness: 2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 - b. Rigid Board: Ducts over 18" wide.
 - 1) Minimum Thickness: 1-1/2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 - 2. Exposed inside building envelope:
 - a. Rigid Board
 - 1) Minimum Thickness: 1-1/2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
- C. Air Conditioning Supply and Return; Heating Supply and Return:
 - 1. Concealed inside building envelope in unconditioned spaces:
 - a. Flexible Blanket: Ducts up to 18" wide.
 - 1) Minimum Thickness: 2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 - b. Rigid Board: Ducts over 18" wide.
 - 1) Minimum Thickness: 1-1/2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 - 2. Exposed inside building envelope in unconditioned spaces and mechanical rooms:
 - a. Rigid Board
 - 1) Minimum Thickness: 1-1/2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 - 3. Exposed inside building envelope in conditioned spaces:
 - a. Uninsulated unless otherwise indicated on Drawings.
 - 4. Inside building envelope, exposed to outside air (i.e., ventilated attic):
 - a. Flexible Blanket: Ducts up to 18" wide.
 - 1) Minimum Thickness: 4 inches.

- 2) Minimum R value: R-12.
- 3) Jacket Type: Vapor Barrier.
- b. Rigid Board: Ducts over 18" wide.
 - 1) Minimum Thickness: 3 inches.
 - 2) Minimum R value: R-12.
 - 3) Jacket Type: Vapor Barrier.
- D. Duct Liner:
 - 1. Provide where shown on drawings.

END OF SECTION

**SECTION 23 0716
HVAC EQUIPMENT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Covering.

1.02 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- C. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- F. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.04 DELIVERY, STORAGE, AND HANDLING

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

1.05 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.

3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible.
1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 2. Secure with self-sealing longitudinal laps and butt strips.
 3. Secure with outward clinch expanding staples and vapor barrier mastic.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville Corporation: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 850 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with self-sealing longitudinal laps and butt strips.
 4. Secure with outward clinch expanding staples and vapor barrier mastic.

2.04 HYDROUS CALCIUM SILICATE

- A. Manufacturer:
1. Johns Manville Corporation: www.jm.com/#sle.
- B. Insulation: ASTM C533; rigid molded, asbestos free, gold color.
1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 1200 degrees F.
 3. Density: 15 lb/cu ft.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
1. Aeroflex USA, Inc: www.aeroflexusa.com/#sle.
 2. Armacell LLC: www.armacell.us/#sle.
 3. K-Flex USA LLC: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
1. Minimum Service Temperature: Minus 40 degrees F.
 2. Maximum Service Temperature: 220 degrees F.
 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.06 JACKETS

- A. PVC Plastic:
1. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.

- c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
- B. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
- 1. Lagging Adhesive: Compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated equipment containing fluids below ambient temperature; insulate entire system.
- G. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.
- H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- J. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- K. Inserts and Shields:
 - 1. Application: Equipment 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between hangers and inserts.
 - 3. Insert Location: Between support shield and equipment and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- L. Finish insulation at supports, protrusions, and interruptions.
- M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Air Separators:
 - 2. Expansion Tanks:
 - 3. Hot Thermal Storage Tanks:
- B. Cooling Systems:
 - 1. Pump Bodies:
 - 2. Air Separators:
 - 3. Expansion Tanks:

4. Chiller Cold Surfaces (Not Factory Insulated):

END OF SECTION

**SECTION 23 0719
HVAC PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.
- D. Engineered wall outlet seals and refrigerant piping insulation protection.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping: Placement of hangers and hanger inserts.
- B. Section 23 2300 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
- H. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- K. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- L. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- M. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- N. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 GLASS FIBER, RIGID

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
- F. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 CELLULAR GLASS

- A. Pipe and Tubing Insulation: ASTM C552, Type II, Grade 6.
 - 1. K Value: 0.35 at 100 degrees F.
 - 2. Service Temperature Range: From 250 degrees F to 800 degrees F.
 - 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 - 4. Water Absorption: 0.5 percent by volume, maximum.
 - 5. Density: A minimum of 6.12 lb/cu ft.
- B. Block Insulation: ASTM C552, Type I, Grade 6.
 - 1. K Value: 0.35 at 100 degrees F.
 - 2. Service Temperature: 800 degrees F, maximum.
 - 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 - 4. Water Absorption: 0.5 percent by volume, maximum.

2.04 HYDROUS CALCIUM SILICATE

- A. Manufacturers:
 - 1. Johns Manville Corporation: www.jm.com/#sle.
- B. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
 - 1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F.
 - 3. Density: 15 lb/cu ft.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Aeroflex USA, Inc; Aerocel Ultra-Low Perm (ULP): www.aeroflexusa.com/#sle.
 - 2. Armacell LLC; AP Armaflex: www.armacell.us/#sle.
 - 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.

1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 180 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.06 JACKETS

A. PVC Plastic.

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

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.

1. Thickness: 0.016 inch sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.07 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

A. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.

1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch.
2. Outlet Cover Color: White.
3. Water Penetration: Comply with ASTM E331.
4. Air Leakage: Comply with ASTM E283.

B. Insulation Protection System: Refrigerant piping insulation PVC protective cover.

1. PVC Insulation Cover Color: White with full-length velcro fastener.
2. Weatherization and Ultraviolet Exposure Protection: Comply with ASTM G153.
3. Water/Vapor Permeability: Comply with ASTM E96/E96M.
4. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- G. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- H. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert location: Between support shield and piping and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

- A. Heating Systems:
1. Heating Water Supply and Return:
 2. Glycol Heating Supply and Return:
 3. Boiler Feed Water:
- B. Cooling Systems:
1. Chilled Water:
 2. Glycol Cooling Supply and Return:
 3. Condensate Drains from Cooling Coils:
 4. Refrigerant Suction:
 5. Refrigerant Hot Gas:

END OF SECTION

**SECTION 23 0923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

1.01 DESCRIPTION OF WORK

- A. The Owner will furnish all Siemens control devices that are included in this section by OGS/GSA contract. The Mechanical Contractor will be responsible for contracting with the temperature controls provider for wiring, programming, commissioning, etc. The mechanical Contractor shall also be responsible for installing control components in the piping and duct work systems, such as but not excluding the following: Automatic Control Dampers, Automatic Control Valves, Temperature Sensing Thermal Wells and Pressure Control Sensing Taps. The Temperature Controls Contractor (TCC) shall be a factory trained and authorized Siemens Industry, Inc. APOGEE Branch Office.
1. This project is a design make Siemens Desigo Control System. See section 2.1 of this specification for Acceptable Manufacturers.
 2. Furnish all labor, materials, equipment, and service necessary to provide a complete and operating temperature control system. System shall use Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein. Control sequences are specified in this section.
 - a. All actuation of valves and dampers shall be electric unless specifically called out elsewhere in the specifications or drawings.
 3. The Building Automation System (BAS) shall have the following capabilities as described in these specifications:
 - a. The Network Control Units (NCU)(s) and Computer(s) shall be connected directly to the Owners Ethernet Network.
 - b. If existing, off-site access for Owner's personnel shall be extended to include new work herein. Identical graphical displays shall be provided for offsite access to match the displays at the on-site Operator Workstation. Connection to the site shall be via a high speed Ethernet connection. The contractor shall coordinate with the Owners IT professionals for high speed system access and shall comply with Owners requirements to maintain the level of security required by the Owner.
 - c. The BMS network controller shall integrate into the existing Siemens Desigo CC server.
 - d. All system variables in the BMS system shall be Microsoft variables allowing them to be displayed and manipulated in other Microsoft products.
 - e. Network controllers shall all be flash upgradeable and not require changing chips for upgrades.
 - f. Short term logging of historical data shall be provided for every DDC input and output in the system. Each point shall be logged for a minimum of 2 weeks.
- B. **QUALITY ASSURANCE**
1. All labor, material, equipment and software necessary to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be provided by one of the manufacturers listed in Part 2 - Products. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner. This contractor also is responsible for all costs of changes in the work required by substitute equipment.
 2. The Building Management System (BMS) Contractor must have been in business for not less than 10 years, and providing BMS systems must be the Contractors primary business. BMS Contractor must be an authorized branch office of the manufacturers specified. BMS Contractor must have a trained staff of application engineers, project managers, software engineers, commissioning staff, and service staff experienced in the configuration, programming and service of the automation system.
 3. The BMS Contractor shall have a training facility with regularly scheduled training as outlined in Section 1.4 so as to provide ongoing regularly scheduled application training.
 4. Manufacturer: A firm regularly engaged in manufacture of microprocessor temperature control equipment, of types and sizes which are similar to required equipment, and which have been in satisfactory use for not less than 10 years, in similar service.
 5. Electrical standards: Provide electrical products that comply with the following agency approvals:

- a. UL-916; Energy Management Systems for BAS components and ancillary equipment
 - b. UL-873; Temperature Indication and Regulating Equipment
 - c. FCC, Part 15, Subpart J, Class A Computing Devices
6. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

C. SCOPE OF WORK

1. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators and other accessory equipment, along with a complete system of electrical interlocking wiring as required to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
2. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
3. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor shall review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system to the Owner and prove that it complies with the intent of the drawings and specifications.
 - a. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification.
4. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative. Commissioning reports showing the testing of each DDC point on the system shall be submitted to the Engineer for review and approval upon completion of the commissioning process. See Section 3.6 Commissioning and System Startup section for detail.
5. All work performed under this section of the specifications shall comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project for code compliance. If this specification and associated drawings exceed governing code requirements, the specification shall govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

D. TRAINING

1. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel per the following description:
 - a. On-site training shall consist of a minimum of (4) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:
 - 1) System Overview
 - 2) System Software and Operation
 - (a) System access
 - (b) Software features overview
 - (c) Changing setpoints and other attributes
 - (d) Scheduling
 - (e) Editing programmed variables
 - (f) Displaying color graphics
 - (g) Running reports
 - (h) Workstation maintenance
 - (i) Application programming
 - 3) Operational sequences including start-up, shutdown, adjusting and balancing.
 - 4) Equipment maintenance.

2. Classroom training shall include a minimum of (1) training slot for two days of course material covering workstation operation and controller programming. The cost for travel and lodging shall be included in this contract if Training Center is more than 150 miles from the Project Site.
3. The training facility shall have the capability to provide hands on training experience for all applications that can be run on the Siemens controls application.

E. SYSTEM DESCRIPTION

1. The Building Automation System (BAS) shall consist of PC-based workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.
2. For this project the system shall consist of the following components:
 - a. Operator Workstation and Server: Utilize Existing Siemens APOGEE (1) File Server and workstations. No third-party front-end workstation software will be acceptable.
 - b. Ethernet-based Network Controller(s): The BAS Contractor shall furnish (1) Ethernet-based network controllers as described in Part 2 of the specification. If the existing controller is sufficient to include the new work, a new controller is not required. These controllers shall connect directly to the Operator Workstation over Ethernet, provide communication to the Standalone Digital Control Units and/or other Input/Output Modules and serve as a gateway to equipment furnished by others (if applicable).
 - c. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU shall operate completely standalone, containing all of the I/O and programs to control its associated equipment.
 - d. A high-speed Ethernet connection to the school shall be furnished by the school district. BMS contractor shall coordinate with the Owners IT professionals and comply with the Owner's IT professionals requirements.

F. WORK BY OTHERS

1. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
2. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment specified in this section for installation by the Mechanical Contractor.
3. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 - a. Automatic Control Dampers
 - b. Automatic Control Valves.
 - c. Temperature Sensing Thermal Wells
 - d. Pressure Control Sensing Taps

G. WARRANTY AND ACCEPTANCE

1. The microprocessor temperature control contractor shall warrant the control system installed in this contract to be free from defects in material and workmanship, except for damages from other causes, for a period of one year after final acceptance from the owner. The microprocessor temperature control contractor shall be responsible for all necessary revisions to the software required for a workable system performance through the first year of operation. Any changes in the software shall be transmitted immediately to the owner. The software responsibility is for a complete and workable system as described in the control cycle description of the specification. The software shall become the property of the owner.
2. Updates to the manufacturer's software shall be provided at no charge during the warranty period, unless otherwise purchased by the District under a service agreement.
3. All equipment required to maintain operation of the temperature control system for the project shall be stocked in the microprocessor temperature control contractor's local facility. It shall be immediately available in the event of component failure. A spare or loaner piece of equipment shall be installed immediately when a failure occurs and the equipment shall be returned to the factory for repair.

H. SUBMITTALS

1. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical schematics will be allowed where appropriate.
 - a. Each drawing containing an equipment schematic shall contain a table indicating what equipment is covered by this drawing (i.e. equipment "tag #") and which drawing in the Construction Document set this piece of equipment is shown on.
 2. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.
 3. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three-ring binder with an index and tabs.
 4. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. Prior to submitting, the Contractor shall check all documents for accuracy.
 5. The Engineer will make corrections, if required, and return to the Contractor. The Contractor shall then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
 6. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS shall be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
 7. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. See Section 3.6 for detail required in Commissioning the system.
 8. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.
- I. OPERATING AND MAINTENANCE MANUALS
1. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead-time and expected frequency of use of each part clearly identified.
 2. Following project completion and testing, the BAS contractor shall submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software in written form.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer - Provide the following microprocessor control system:
 1. Siemens Industry, Inc. Desigo BAS. All control devices shall be purchased by the Owner and installed by the Temperature Controls Contractor (TCC). The TCC shall be a factory trained and authorized Siemens Industry, Inc. factory branch office. Contact: Robert Lightfoot, Siemens industry, Inc. 6075 East Molloy Road, Syracuse NY 13211 (315) 296-8737.
- B. SYSTEM ARCHITECTURE

1. The Building Management System (BMS) shall consist of Network Area Controllers (NACs), a family of Local Controllers, Administration and Programming Workstations (APWs), Operator Workstations (OWs), and a File Server to support system configurations where more than three operator workstations are required. The BMS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant SQL database. The system shall be designed with a top-level 10/100bT Ethernet network, using ISO 8802-3 data link/physical layer. A sub-network using the RS-485 token passing protocol, with a minimum of 19.2kb speed, shall connect the local, stand-alone controllers with Ethernet-level controller/routers.
2. Level 1 Network Description: Level 1, the main backbone of the system, shall be an ISO 8802-3, 10/100bT LAN/WAN, using Ethernet as the communications protocol. Network Area Controllers, Operator Workstations, and Servers shall connect directly to this network without the need for Gateway devices.
3. Level 2 Network Description: Level 2 of the system shall consist of one or more local Controllers. Minimum speed shall be 19.2kbps. The Level 2 field bus consists of an RS485, token passing bus that supports up to 127 Local Controllers to operate HVAC equipment, lighting, power metering and monitoring, fuel tank monitoring, UPS battery and generator monitoring, smoke and fire detection, water leak detection, and video surveillance and access control.
4. BMS LAN Segmentation: The BMS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.
5. Standard Network Support: All NACs, Workstations and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NACs, Workstations and Servers shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Technology (IT) Department as all devices utilize standard TCP/IP components.
6. System Expansion: The BMS shall be scalable and expandable at all levels using the same software interface and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
 - a. The BMS shall be expandable to include Video Surveillance and Access Control functions at any time in the future without requiring additional workstations, front-end software or Level 1 controllers. Biometric readers, keypads or proximity card access controllers shall be able to be added to the existing Level 1 network, to perform security and access control applications. In this way, an owner's existing investment in wiring infrastructure may be leveraged and the cost and inconvenience of adding new field bus wiring can be minimized.
 - b. Additional web-based operator licenses shall be added in the field through an upgrade of the web server's security key, with no re-programming required.
 - c. The system shall use the same application programming language for all levels: Operator Workstation, Network Area Controller, and Interoperable Digital Controller. Furthermore, this single programming language shall be used for all applications: environmental control, biometric, keypad and card access control, intrusion detection and security, lighting control, leak detection/underground storage tank monitoring, electrical, power metering, video surveillance and digital data communication interfaces to third-party microprocessor-based devices.
7. Support for Open Systems Protocols: The BMS design must include solutions to integrate the following open system protocols: BACnet, Modbus, and digital data communication to third party microprocessors such as chiller controllers, smoke, fire and life safety panels and variable frequency drives (VFDs) – as required to complete the work.

C. NETWORK CONTROL UNITS (NCUs) – Siemens PXC/PXM controllers are basis of design

1. General: Reuse existing Network Control Units (NCUs).
- D. LOCAL CONTROLLERS – Siemens PXC/PXM controllers are basis of design.
1. General: Local Controllers shall provide control of HVAC, CRAC units, lighting, power metering, electrical monitoring, UPS, and leak detection. This may include air handling units, rooftop units, variable air volume boxes, unit ventilators, smoke, fire and life safety systems, and other mechanical equipment. Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated NAC.
 2. Hardware Specification:
 - a. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, flash memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
 - b. Communication Ports: Local Controllers shall have a RS-485 communication port field bus, operating at a speed of at least 19.2kbps.
 - c. Input/Output: Each local Controller shall have enough inputs and outputs to meet the application's required point count. Each local controller shall support universal inputs, whereas any input may be software-defined as:
 - 1) Digital Inputs for status/alarm contacts
 - 2) Counter Inputs for summing pulses from meters.
 - 3) Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
 - 4) Analog inputs for pressure, humidity, flow and position measurements.
 - d. Local controllers must support both digital and analog output types:
 - 1) Digital Outputs for on/off equipment control.
 - 2) Analog Outputs for valve and damper position control, and capacity control of primary equipment.
 - e. Expandability: For larger controllers (16 base inputs and up), provide input and output expansion through the use of plug-in modules. At least two I/O modules must be capable of being added to the base Local Controller.
 - f. Hardware Override Switches: All digital outputs on air handling unit controllers shall include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output on air handling unit controllers shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3-position manual override switch is placed in the ON position.
 - g. Networking: Each local controller will be able to exchange information on a peer-to-peer basis with other Interoperable Digital Controller. Each local controller shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each local controller shall be able to have its program viewed and/or enabled/disabled through a workstation connected to an NAC.
 - h. Indicator Lamps: Local Controllers will have as a minimum, LED indication of CPU status, and field bus status.
 - i. Real Time Clock (RTC): All Local Controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each Local Controller shall receive a signal, every hour, over the network from the NAC, which synchronizes all Local Controllers real time clocks.
 - j. Automatic Restart after Power Failure: Upon restoration of power, the Local Controller shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

- k. Battery Back Up: All Local Controllers shall store all programming in non-volatile flash memory. All Local Controllers except terminal controllers shall include an on-board lithium battery to back up the controller's RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the Local Controller shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the Local Controller shall restart itself from its application program stored in its flash memory.
3. Software Specification:
- a. General: The Local Controller shall contain flash memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each Local Controller shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
 - b. User Programming Language:
 - 1) The application software shall be user-programmable, using the same language as that defined for Network Area Controllers. Controllers should be freely programmable. Fixed function controllers will not be accepted.
 - 2) Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Area Controller.
 - c. History Logging: Each controller shall be capable of locally logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
 - d. Alarm Management:
 - 1) For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the Local Controllers and can result in the display of one or more alarm messages or reports.
 - 2) Up to 8 alarms can be configured for each point in the controller.
 - 3) Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
 - 4) If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the controller. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.
4. Air Handler Controllers
- a. AHU Controllers shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification and for future expansion.
 - b. AHU Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.
 - c. AHU Controllers shall be fully user programmable to allow for modification of the application software.
5. VAV Terminal Unit Controllers
- a. VAV Terminal Unit Controllers shall support, but not be limited to the control of the following configurations of VAV boxes to address current requirements as described in the Execution portion of this specification, and for future expansion:
 - 1) Single Duct Cooling Only
 - 2) Single Duct Cooling with Reheat (Electric or Hot Water)
 - 3) Fan Powered (Parallel or Series)
 - 4) Dual Duct (Constant or Variable Volume)
 - 5) Supply/Exhaust

- b. VAV Controllers for single duct applications will come equipped with a built-in actuator for modulation of the air damper. The actuator shall have a minimum torque rating of 35 in.-lb., and contain an override mechanism for manual positioning of the damper during startup and service.
 - c. VAV Controllers shall contain an integral velocity sensor accurate to +/- 5% of the full range of the box's CFM rating.
 - d. Each controller shall perform the sequence of operation described in Part 3 of this specification, and have the capability for local time-of-day scheduling, occupancy mode control, after-hours operation, lighting control, alarming, and trending.
6. Unitary Controllers – Siemens TECs, 540/550 Series Controllers
- a. Unitary Controllers shall support, but not be limited to, control of the following systems as described in the Execution portion of this specification, and for future expansion:
 - 1) Unit Ventilators
 - 2) Heat Pumps (Air to Air, Water to Water)
 - 3) Packaged Rooftops
 - 4) Fan Coils (2 or 4 Pipe)
 - b. The I/O of each Unitary Controller shall contain sufficient quantity and types, as required, to meet the sequence of operations found in the Execution portion of this specification. In addition, each controller shall have the capability for local time of day scheduling, occupancy mode control, after hour operation, lighting control, alarming, and trending.
- E. COMMUNICATIONS TO 3RD PARTY DEVICES
- 1. General: Where required, provide a Gateway to interface to that equipment that use the Modbus protocol, or other proprietary or open protocols.
 - 2. Communication Ports: In addition to its on-board Ethernet port, the Gateway shall have at least two serial communications ports for interfaces to third-party systems.
 - 3. Memory: The Gateway shall have enough RAM memory to store all point configuration data, plus required history logging and alarm buffering. Minimum RAM shall be 8MB. The operating system of the gateway must be stored in flash non-volatile memory.
 - 4. User Programming Language:
 - a. The Gateway shall employ the same user programmable application software that NACs and Local Controllers use.
 - b. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Area Controller. Gateways that do not have an application programming language will not be accepted.
 - 5. History Logging: Each Gateway shall be capable of locally logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
- F. WORKSTATIONS AND SOFTWARE – Utilize Existing Siemens Desigo
- G. DDC SENSORS AND POINT HARDWARE
- 1. General: Where indicated on the drawings, schedules or sequence of operations, provide equipment that conforms to the following specifications:
 - 2. Temperature Sensors:
 - a. All temperature devices shall use precision thermistors accurate to +/- 0.36°F over a range of -30 to 230°F.
 - b. Standard space sensors shall be provided in an off-white enclosure for mounting on a standard electrical box.
 - c. Where manual override of unoccupied mode of control is indicated on the drawings or sequence of operation, provide a push button for selecting after hours operation.
 - d. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless-steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified.

- e. Averaging sensors shall be employed in all mixing plenum applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
 - f. Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
3. Pressure Sensors:
- a. Air pressure or differential air pressure measurements in the range of 0 to 10" water column shall be accurate to +/- 1% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Setra model C-264.
 - b. Liquid pressure or differential liquid pressure measurements shall be accurate to +/- 0.25% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-230.
4. Low Limit Thermostats:
- a. Safety low limit thermostats shall be vapor pressure type with a 20-foot minimum element. Element shall respond to the lowest temperature sensed by any one-foot section. Provide one thermostat for each 25 square foot of coil area.
 - b. Low limit thermostat shall be manual reset and shall be double pole so as to provide input capability for alarm at the BAS.
5. Current Sensing Status Switches
- a. Current status switches shall be used to monitor the run status of fans, pumps, motors and electrical loads. Acceptable manufacturer is Veris or approved equal.
6. Control Valves
- a. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves that mate and match the material of the connected piping.
 - b. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Valves shall be selected to provide an initial pressure drop of not more than 4 psig for water applications. For low pressure steam application, the pressure drop shall be equal to the supply pressure minus the heating element design inlet pressure.
 - c. Normal position of both heating and cooling valves shall be open. Three Way valves shall be piped to fail open to both heating and cooling.
 - d. Electric Bi-Directional actuators are acceptable on VAV Terminal Units and Reheat coil valve control if so noted.
 - e. All electric actuators for applications other than VAV terminal units and Reheat Coil valve Control shall be Proportional analog 4-20Ma or 0-10Vdc input and shall be positioned to reflect the output value of the computer control system and shall be spring return to normal position.
7. Dampers
- a. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers shall be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
 - b. Damper frames shall be hat shaped channel, 4" deep constructed of 16-gauge galvanized steel. Stainless steel side seals, and sintered bronze, oil-impregnated bearings shall also be provided.
 - c. Damper blades shall be 16-gauge galvanized steel and shall be 6" on center. Provide vinyl-grip seals on blades.

- d. Provide damper linkage that consists of 0.50" diameter steel, cadmium plated and chromate treated pivots. Provide a ¼-20 set-screw with a locking-patch to lock the pivots to a 0.31 diameter aluminum rod. Pivots shall rotate in a Celcon bearing. Blade brackets shall be 12-gauge cadmium plated steel. Blades shall be individually factory adjusted for maximum shut off.
- e. Provide axles that are steel, 0.350" diameter cadmium plated and driveshafts that are ½" diameter cadmium plated steel, extendable 6".
- f. For high performance applications, control dampers shall meet or exceed the UL Class I leakage rating.
- g. Control dampers shall be Ruskin, Arrow or approved equal.
- h. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control.

PART 3 - EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES

- A. Demolition: Remove controls which do not remain as part of the building automation system, including all associated abandoned wiring, conduit, and pneumatic tubing within visible area of the new controls, up-to 10 feet away. The Owner will inform the Contractor of any equipment that is to be removed that will remain the property of the Owner. This equipment shall be handled with care so as not to damage it. All other equipment that is removed shall be disposed of by the Contractor.
- B. Cleanup: At the completion of the work, all equipment pertinent to this section shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this section. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.
- C. Wiring, Conduit and Cable
 - 1. ALL wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes and Division 16 (Electrical division) specification.
 - a. All temperature control cable less than 50 volts is to be considered low voltage.
 - b. All low voltage cable is to be run in conduit in any non-accessible concealed space and up to 10 ft. above floor level within mechanical rooms. Wiring above 10 ft or within accessible areas (ceilings, crawl spaces, between furred walls, enclosed chases) may be run exposed with proper support with bridle rings. Wiring is to be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.
 - c. Sensors and wiring on or in concrete or block walls for low voltage cable shall be surface mounted and enclosed in metallic wire-mold.
 - d. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.
 - e. Any cable running in plenum rated areas shall be plenum rated cable.
 - f. Wires and tubing shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.
 - g. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each temperature control panel or controller.
 - h. Metallic surface raceway may be used in finished areas on non-accessible masonry walls. All surface raceway in finished areas shall be color matched to the existing finish within the limitations of standard manufacturers' colors.
- D. **HARDWARE INSTALLATION**
 - 1. Installation Practices for Field Devices
 - a. Actuators shall be firmly mounted to give positive movement, and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the actuator stroke.
 - b. Actuators shall be stroked ~5%, tightened and returned to normal position to give a positive seal.
 - c. Relay outputs shall 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. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
 - f. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. The low-pressure port shall be piped to the outside of the building.
2. Enclosures:
- a. For all I/O requiring field interface devices, these devices where practical shall be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust and moisture, and conceals integral wiring and moving parts.
 - b. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
 - c. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. All locks shall be keyed identically.
 - d. All outside mounted enclosures shall meet the NEMA-4 rating.
- E. SOFTWARE INSTALLATION
- 1. General: 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.
 - 2. Database Configuration: The Contractor shall provide all labor to configure those portions of the database that are required by the point list and sequence of operation.
 - 3. Color Graphic Slides: Unless otherwise directed by the owner, the Contractor shall provide color graphic displays as depicted in the schematic drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.
- F. COMMISSIONING AND SYSTEM STARTUP
- 1. Point to Point Checkout: Each I/O device (both field mounted and those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
 - 2. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
 - 3. System Acceptance Testing:
 - a. All application software shall be verified and compared against the sequences of operation. Control loops shall be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
 - b. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
 - c. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
 - d. Perform an operational test of each third-party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION

**SECTION 23 2113
HYDRONIC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment.
- C. Section 23 0719 - HVAC Piping Insulation.
- D. Section 23 2114 - Hydronic Specialties.
- E. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- D. ASME B31.9 - Building Services Piping.
- E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- H. ASTM A536 - Standard Specification for Ductile Iron Castings.
- I. ASTM B32 - Standard Specification for Solder Metal.
- J. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- L. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
- M. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- N. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- O. AWS D1.1/D1.1M - Structural Welding Code - Steel.

- P. AWWA C606 - Grooved and Shouldered Joints.
- Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.
 - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.05 QUALITY ASSURANCE

- A. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- B. Coupling Manufacturer:
 - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
 - 3. A distributor's representative is not considered qualified to perform the training.
- C. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
 - b. Use rigid joints unless otherwise indicated.
 - c. Use gaskets of molded synthetic rubber with central cavity, pressure-responsive configuration, and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
 - 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 - 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 - 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Apollo Valves: www.apollovalves.com/#sle.
 - 2) Grinnell Products: www.grinnell.com/#sle.
 - 3) Viega LLC: www.viega.us/#sle.

2.03 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 - 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Apollo Valves: www.apollovalves.com/#sle.
 - 2) Grinnell Products: www.grinnell.com/#sle.
 - 3) Viega LLC: www.viega.us/#sle.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

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

2.05 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.

5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
 8. Vertical Support: Steel riser clamp.
 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.
- C. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
1. Bases: High-density polypropylene.
 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 3. Steel Components: Stainless steel or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion-resistant material.
 5. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
 6. Manufacturers:
 - a. PHP Systems/Design: www.phpsd.com/#sle.

2.06 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

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

- b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
- c. Dry insulation barrier able to withstand 600-volt breakdown test.
- d. Construct of galvanized steel with threaded end connections to match connecting piping.
- e. Suitable for the required operating pressures and temperatures.

2.07 BALL VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Victaulic Company: www.victaulic.com/#sle.
- B. Up To and Including 2 Inches:
 - 1. Bronze one piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
- C. Over 2 Inches:
 - 1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle or gear operated, flanged ends, rated to 800 psi.

2.08 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Victaulic Company: www.victaulic.com/#sle.
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
- C. Disc: Construct of chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- D. Stem: Stainless steel with stem offset from the centerline to provide full 360-degree circumferential setting.
- E. Operator: 10 position lever handle.

2.09 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Victaulic Company: www.victaulic.com/#sle.
- B. Up To and Including 2 Inches:
 - 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.
- C. Over 2 Inches:
 - 1. Iron body, bronze trim, stainless steel or bronze swing disc, renewable disc and seat, flanged or grooved ends.

2.10 SPRING LOADED CHECK VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
 - 3. Victaulic Company: www.victaulic.com/#sle.
- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

2.11 FLOW CONTROLS

- A. Manufacturers:
 - 1. Griswold Controls: www.griswoldcontrols.com/#sle.

2. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
 4. Victaulic Company: www.victaulic.com/#sle.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, glycol, chilled water piping to ASME B31.9 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interference with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors.
- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- H. Slope piping and arrange to drain at low points.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.
- J. Grooved Joints:
 1. Install in accordance with the manufacturer's latest published installation instructions.
 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- K. Inserts:
 1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- L. Pipe Hangers and Supports:
 1. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 2. Place hangers within 12 inches of each horizontal elbow.
 3. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 6. Provide copper plated hangers and supports for copper piping.

- M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.
- N. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 4. 2-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Piping.
 - 1. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 2. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 3. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 - 4. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 - 5. 8 Inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
 - 6. 10 Inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.

END OF SECTION

**SECTION 23 2114
HYDRONIC SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

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

1.03 REFERENCE STANDARDS

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

PART 2 PRODUCTS

2.01 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com/#sle.
 - 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi.
- D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B. Manual Type: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:

1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.03 AIR SEPARATORS

- A. Coalescing Air/Dirt Separators:
 1. Manufacturers:
 - a. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - b. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - c. Spirotherm, Inc: www.spirotherm.com/#sle.
 2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1; for 150 psi operating pressure and 270 degrees F maximum operating temperature; subject to the requirements of the application and the manufacturer's standard maximum operating conditions.
 3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
 4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to the top of the separator.
 5. Inlet and Outlet Connections: Threaded for 2 NPS and smaller; Class 150 flanged connections for 2-1/2 NPS and larger.
 6. Blowdown Connection: Threaded.
 7. Size: Match system flow capacity.

2.04 STRAINERS

- A. Manufacturers:
 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 2. Grinnell Products: www.grinnell.com/#sle.
 3. The Metraflex Company: www.metraflex.com/#sle.
- B. Size 2 inch and Under:
 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
 1. Provide flanged or grooved iron body for 175 psi working pressure, Y pattern with 1/16 inch or 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
 1. Provide flanged or grooved iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.05 SUCTION DIFFUSERS

- A. Manufacturers:
 1. Anvil International: www.anvilintl.com/#sle.
 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 3. Victaulic Company of America: www.victaulic.com/#sle.
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.06 PUMP CONNECTORS

- A. Manufacturers:
 1. The Metraflex Company: www.metraflex.com/#sle.

- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 1. Maximum Allowable Working Pressure: 150 psig at 200 degrees F.
 2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: 1 inch.
 - b. Lateral Movement: 1 inch.
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 3. End Connections: Same as specified for pipe jointing.

2.07 COMBINATION PUMP DISCHARGE VALVES

- A. Manufacturers:
 1. Anvil International: www.anvilintl.com/#sle.
 2. Taco, Inc: www.taco-hvac.com/#sle.
 3. Victaulic Company of America: www.victaulic.com/#sle.
- B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.08 PRESSURE-TEMPERATURE TEST PLUGS

- A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- B. Application: Use extended length plugs to clear insulated piping.

2.09 BALANCING VALVES

- A. Manufacturers:
 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 2. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B. Size 2 inch and Smaller:
 1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or grooved connections.
 2. Metal construction materials consist of bronze or brass.
 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- C. Size 2.5 inch and Larger:
 1. Provide globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.10 COMBINATION FLOW CONTROLS

- A. Manufacturers:
 1. Armstrong International: www.armstronginternational.com/#sle.
 2. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
- D. Provide with inlet and outlet unions as required.

- E. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

2.11 RELIEF VALVES

- A. Manufacturers:
 - 1. Apollo Valves: www.apollovalves.com/#sle.
 - 2. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.12 PRESSURE REDUCING VALVES

- A. Manufacturers:
 - 1. Apollo Valves: www.apollovalves.com/#sle.
 - 2. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 2113.
- C. Materials of Construction:
 - 1. Valve Body: Constructed of bronze or brass.
 - 2. Internal Components: Construct of stainless steel or brass and engineered plastics or composition material.
- D. Connections:
 - 1. Soldered: 0.50 inch.
- E. Provide integral check valve and strainer.
- F. Maximum Fluid Temperature: 180 degrees F.

2.13 GLYCOL SYSTEM

- A. Mixing Tank: 55 gallon steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.
- B. Storage Tank: Closed type, welded-steel construction, tested and stamped in accordance with ASME BPVC-VIII-1; 100 psi rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tappings for installation of accessories.
- C. Glycol Solution:
 - 1. Inhibited propylene glycol and water solution mixed 40 percent glycol - 60 percent water, suitable for operating temperatures from minus 40 degrees F to 250 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide valved drain and hose connection on strainer blowdown connection.
- G. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- I. Support pump fittings with floor-mounted pipe and flange supports.
- J. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- L. Clean and flush glycol system before adding glycol solution. Refer to Section 23 2500.
- M. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- N. Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION

**SECTION 23 2123
HYDRONIC PUMPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line circulators.
- B. Base-mounted pumps.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete.
- B. Section 23 2113 - Hydronic Piping.
- C. Section 23 2114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

- A. UL 778 - Standard for Motor-Operated Water Pumps.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com.
- B. Armstrong Fluid Technology, Inc: www.armstrongfluidtechnology.com/#sle.
- C. Taco; www.taco.com

2.02 HVAC PUMPS - GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

2.03 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Cadmium plated steel, keyed to shaft.
- D. Bearings: Permanently-lubricated ball bearings.
- E. Shaft: Stainless steel with bronze sleeve, integral thrust collar.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Drive: Flexible coupling.

2.04 BASE-MOUNTED PUMPS

- A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure.

- B. Casing: Cast iron, or ductile iron with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed to shaft.
- D. Bearings: Oil lubricated roller or ball bearings.
- E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 250 degrees F maximum continuous operating temperature.
- H. Drive: Flexible coupling with coupling guard.
- I. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and pump suction fitting on pump suction, and line sized combination pump discharge valve on pump discharge.
- E. Provide drains for bases and seals, piped to and discharging into floor drains.
- F. Check, align, and certify alignment of base-mounted pumps prior to start-up.
- G. Install base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 3000.
- H. Lubricate pumps before start-up.
- I. Provide side-stream filtration system for closed loop systems. Install across pump with flow from pump discharge to pump suction from pump tapings.

END OF SECTION

**SECTION 23 2300
REFRIGERANT PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Filter-driers.
- G. Expansion valves.
- H. Flexible connections.

1.02 RELATED REQUIREMENTS

- A. Section 08 3100 - Access Doors and Panels.
- B. Section 22 0719 - Plumbing Piping Insulation.
- C. Section 23 0719 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS

- A. AHRI 750 - Thermostatic Refrigerant Expansion Valves.
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems.
- C. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- E. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
- F. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- G. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- H. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- I. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.

1. Fittings: ASME B16.22 wrought copper.
 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
- B. Pipe Supports and Anchors:
1. Provide hangers and supports that comply with MSS SP-58.
 - a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 6. Vertical Support: Steel riser clamp.
 7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 9. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.02 REFRIGERANT

- A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
- B. Refrigerant: R-410A as defined in ASHRAE Std 34.

2.03 MOISTURE AND LIQUID INDICATORS

- A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.04 VALVES

- A. Diaphragm Packless Valves:
 1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- B. Packed Angle Valves:
 1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- C. Service Valves:
 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.05 STRAINERS

- A. Straight Line or Angle Line Type:
 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.06 FILTER-DRIERS

- A. Performance:
 1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
 2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
 3. Design Working Pressure: 350 psi, minimum.
- B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

- C. Construction: UL listed.
 - 1. Connections: As specified for applicable pipe type.

2.07 EXPANSION VALVES

- A. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.
- B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.08 FLEXIBLE CONNECTORS

- A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- G. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.5.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Provide copper plated hangers and supports for copper piping.
- H. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 3100.

- K. Flood piping system with nitrogen when brazing.
- L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- M. Insulate piping and equipment; refer to Section and Section 22 0716.
- N. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- O. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- P. Fully charge completed system with refrigerant after testing.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION

**SECTION 23 2500
HVAC WATER TREATMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Materials.
 - 1. System cleaner.
 - 2. Closed system treatment (water).
- B. Cleaning of piping systems and heat exchangers..
- C. Cleaning of existing system prior to connection of new work.
- D. Chemical treatment.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2114 - Hydronic Specialties.

1.03 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures for submittal process.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- D. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Sufficient chemicals for treatment and testing during required maintenance period.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum 3 years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. AmSolv-Amrep, Inc: www.amsolv.com.
- B. GE Water & Process Technologies: www.gewater.com.
- C. Nalco, an Ecolab Company: www.nalco.com.

2.02 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Perform work in accordance with local health department regulations.

2.03 MATERIALS

- A. System Cleaner:

1. THIS SECTION FOR REFERENCE ONLY. CONSULT CHEMICAL TREATMENT EXPERT FOR CHEMICALS APPROVED FOR PIPE, HEAT EXCHANGER, VALVE AND GASKET MATERIALS PRESENT IN SYSTEM.
 2. Manufacturers:
 - a. AmSolv-Amrep, Inc: www.amsolv.com.
 - b. GE Water & Process Technologies: www.gewater.com.
 - c. Nalco, an Ecolab Company: www.nalco.com.
 3. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripolyphosphate and sodium molybdate.
 4. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite.
- B. Closed System Treatment (Water):
1. THIS SECTION FOR REFERENCE ONLY. CONSULT CHEMICAL TREATMENT EXPERT FOR CHEMICALS APPROVED FOR PIPE, HEAT EXCHANGER, VALVE AND GASKET MATERIALS PRESENT IN SYSTEM.
 2. Manufacturers:
 - a. AmSolv-Amrep, Inc: www.amsolv.com.
 - b. GE Water & Process Technologies: www.gewater.com.
 - c. Nalco, an Ecolab Company: www.nalco.com.
 3. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 4. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 5. Conductivity enhancers; phosphates or phosphonates.
- C. Cleaning of existing chilled & hot water system prior to connection of new work. (Field verify and consult existing drawings estimated system volume)
1. Contractor shall flush (with system cleaner) existing system prior to connection of new equipment until the existing system is completely flushed. Following the cleaning process replace all strainers on major pieces of mechanical equipment within the system. Any area's that are completely blocked and can not be removed by flushing shall be brought to the immediate attention of the engineer/architect.

2.04 BY-PASS (POT) FEEDER

- A. Manufacturers:
1. Griswold Controls: www.griswoldcontrols.com.
 2. J. L. Wingert Company: www.jlwingert.com.
 3. Neptune, a brand of the Dover Company: www.neptune1.com.
- B. 6.0 gal quick opening cap for working pressure of 175 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

- A. Concentration:
 1. As recommended by manufacturer.
- B. Chilled Water Systems:
 1. Circulate for 48 hours, then drain systems as quickly as possible.
 2. Refill with clean water, circulate for 24 hours, then drain.
 3. Refill with clean water and repeat until system cleaner is removed.
- C. Plate and Frame Heat Exchangers:
 1. Provide flushing and cleaning sequence per manufacturer's recommendations.

- D. Remove, clean, and replace strainer screens.
- E. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.05 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
 - 1. Provide minimum of two hours of instruction for two people.
 - 2. Have operation and maintenance data prepared and available for review during training.
 - 3. Conduct training using actual equipment after treated system has been put into full operation.

**SECTION 23 3100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Nonmetal ductwork.
- C. Kitchen hood ductwork.

1.02 RELATED REQUIREMENTS

- A. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- B. Section 23 0713 - Duct Insulation: External insulation and duct liner.
- C. Section 23 3300 - Air Duct Accessories.
- D. Section 23 3700 - Air Outlets and Inlets.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- D. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- E. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
- H. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- J. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- L. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines.
- M. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings:
 - 1. Prepare 1/4 inch scale or larger drawings within 30 days after contract award for all areas.
 - a. Incorporate dimensions of actual equipment used. (Including light fixtures, structural steel etc.)
 - b. Show adequate sections, elevations and plan views.
 - c. Indicate all dampers and other required accessories.
 - d. indicate size, type, and location of all access doors.
 - e. Include size and location of all floor, wall and roof openings.
 - f. Indicate elevation above floor and ceiling height for each room.
 - g. Indicate SMACNA pressure class required for all duct.
 - 2. Identify in writing, any deviations from contract Drawings and Specifications.
 - a. Highlight all changes from plans required by obstructions and job conditions.
 - b. If shop standards do not conform in detail to specifications, submit for approval annotated shop standards showing upgrades as required for conformance.

- c. Call to Architect's attention, in writing by separate letter along with samples for clarification, any proposed deviations from contract plans and specifications.

1.05 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (Heating Systems): 2 inch w.g. pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 2 inch w.g. pressure class, galvanized steel.
- E. Return and Relief: 1 inch w.g. pressure class, galvanized steel.
- F. General Exhaust: 1 inch w.g. pressure class, galvanized steel.
- G. Locker Room and Shower Room Exhaust: 1 inch w.g. pressure class, aluminum.
- H. Kitchen Cooking Hood Exhaust: 1 inch w.g. pressure class, stainless steel.
 - 1. Construct of 16 gage, 0.0598 inch sheet steel using continuous external welded joints in rectangular sections.
- I. Dishwasher Exhaust: 1 inch w.g. pressure class, stainless steel.
 - 1. Construct of 16 gage, 0.0598 inch sheet steel using continuous external welded joints in rectangular sections.
- J. Grease Exhaust: 1 inch w.g. pressure class, stainless steel.
 - 1. Construct of 18 gage, 0.0500 inch stainless steel.
 - 2. Construction:
 - a. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
 - 3. Access Doors:
 - a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
 - b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.
- K. Outside Air Intake: 1 inch w.g. pressure class, galvanized steel.
- L. Combustion Air: 1 inch w.g. pressure class, galvanized steel.
- M. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, sound lined galvanized steel..

2.02 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
- C. Stainless Steel for Ducts: ASTM A666, Type 304.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - 3. For Use With Flexible Ducts: UL labeled.
- E. Gasket Tape: Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle rings connections.

- F. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- G. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.

2.03 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

- A. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 1. Manufacture in accordance with SMACNA (DCS).
- B. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 1. Manufacture in accordance with SMACNA (DCS).
- C. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
 1. UL labeled.
 2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 3. Pressure Rating: 4 inches WG positive and 0.5 inches WG negative.
 4. Maximum Velocity: 4000 fpm.
 5. Temperature Range: Minus 20 degrees F to 175 degrees F.
- D. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
- E. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
- F. Kitchen Cooking Hood and Grease Exhaust: Nominal 3 inches thick ceramic fiber insulation between 20 gage, 0.0375 inch, Type 304 stainless steel liner and 24 gage, 0.0239 inch aluminized steel sheet outer jacket.
 1. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
 2. Certified for zero clearance to combustible material in accordance with:
 3. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:
- G. Dishwasher Exhaust: Minimum 21 gage, 0.0344 inch thick, single wall, Type 304 stainless steel.
 1. Single wall, factory built chimney liner system.
 2. Joints to be sealed during installation with factory supplied overlapping V-bands and sealant.

2.05 KITCHEN HOOD EXHAUST DUCTWORK

- A. Fabricate in accordance with ductwork manufacturer's installation instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- D. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. Connect diffusers to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- G. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

END OF SECTION

**SECTION 23 3300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Backdraft dampers - fabric.
- D. Combination fire and smoke dampers.
- E. Duct access doors.
- F. Fire dampers.
- G. Flexible duct connectors.
- H. Smoke dampers.
- I. Volume control dampers.

1.02 RELATED REQUIREMENTS

- A. Section 23 3100 - HVAC Ducts and Casings.
- B. Section 25 3523 - Integrated Automation Control Dampers: Product furnishing.

1.03 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- B. NFPA 92 - Standard for Smoke Control Systems.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- E. UL 555S - Standard for Smoke Dampers.
- F. UL 1978 - Grease Ducts.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.

1.05 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL

- A. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 BACKDRAFT DAMPERS - FABRIC

- A. Fabric Backdraft Dampers: Factory-fabricated.

1. Blades: Neoprene coated fabric material.
2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
3. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.04 COMBINATION FIRE AND SMOKE DAMPERS

2.05 DUCT ACCESS DOORS

- A. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
 1. Less Than 12 inches Square: Secure with sash locks.
 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
 4. High Temperature Duct Access Doors:
 - a. Comply with NFPA 96.
 - b. Comply with UL 1978.
- B. Access doors with sheet metal screw fasteners are not acceptable.

2.06 FIRE DAMPERS

2.07 FLEXIBLE DUCT CONNECTORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.

2.08 SMOKE DAMPERS

- A. Products furnished per Section 25 3523.
- B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- C. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by electric actuator.

2.09 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Splitter Dampers:
 1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .
- C. Single Blade Dampers:
 1. Fabricate for duct sizes up to 6 by 30 inch.
 2. Blade: 24 gage, 0.0239 inch, minimum.
- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
 1. Blade: 18 gage, 0.0478 inch, minimum.
- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.

- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- H. Use splitter dampers only where indicated.

END OF SECTION

**SECTION 23 3423
HVAC POWER VENTILATORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof exhausters.
- B. Fume exhaust fans.

1.02 RELATED REQUIREMENTS

- A. Section 23 3300 - Air Duct Accessories: Backdraft dampers.

1.03 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook.
- B. ANSI Z9.5 - Laboratory Ventilation.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- E. UL 705 - Power Ventilators.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 FIELD CONDITIONS

- A. Permanent ventilators may not be used for ventilation during construction.

PART 2 PRODUCTS

2.01 POWER VENTILATORS - GENERAL

- A. Manufacturers:
 - 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - 2. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
- B. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- C. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- D. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
- E. Fabrication: Comply with AMCA 99.
- F. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- G. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- H. Enclosed Safety Switches: Comply with NEMA 250.

2.02 ROOF EXHAUSTERS

- A. Manufacturers:
 - 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - 2. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
- B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

- C. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.03 FUME EXHAUST

- A. Manufacturers:
 - 1. Greenheck Fan Corporation; [____]: www.greenheck.com/#sle.
 - 2. Strobic Air Corporation; _____: www.strobicair.com/#sle.
- B. Fan Assemblies:
 - 1. Provide unit suitable for maintaining structural integrity and operation in 125 mph wind without external guy-wires or supplemental supports when mounted on manufacturer-supplied roof curbs.
- C. Direct Drive Fan:
 - 1. Fan Wheel:
 - a. Type: Non-overloading, backward inclined centrifugal.
 - b. Material: Aluminum.
 - 2. Housing:
 - a. Rigid internal support structure.
 - b. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
 - c. Provide breather tube for fresh air motor cooling and wiring.
- D. Disconnect Switches:
 - 1. Factory mounted and wired.
 - 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 3. Finish for Painted Steel Enclosures: Provide manufacturer's standard, factory applied gray, or _____ unless otherwise indicated.
 - 4. Positive electrical shutoff.
 - 5. Wired from fan motor to junction box installed within motor compartment.
- E. High Plume Discharge Nozzle with Integral Windband:
 - 1. Provide combination discharge nozzle and windband to induce ambient airflow from outside fan housing and increase discharge velocities to velocities that comply with ANSI Z9.5, minimum 3,000 fpm.
 - 2. Provide a windband with a minimum of 120 inches discharge height above the roof surface.
 - 3. Provide a discharge nozzle that develops a maximum discharge air velocity of 9,500 fpm.
 - 4. Provide drain connection at lowest point of housing.
- F. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips. .
- G. Bypass Air Plenum Box: Designed to secure fans for wind loads up to 125 mph, mixing plenum box features modular construction allowing for multiple configurations and retrofit installation.
 - 1. Match fan housing material of construction, to include integral duct flange to mate to fan inlet.
 - 2. Provide bottom intake mixing plenum box for attachment of building duct.
 - 3. Mount mixing box on heavy duty roof curb.
- H. Isolation Dampers:
 - 1. Parallel blade design, constructed of galvanized steel.
 - 2. Provide 24 volt-powered, modulating actuator, rated for NEMA 250, Type 2 (IP54) environment, to coordinate with fan operation.
- I. Bypass Dampers:
 - 1. Provide modulating bypass damper to maintain fan discharge velocity.

2. Provided opposed blade design, constructed of galvanized steel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with stainless steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- D. Provide sheaves required for final air balance.

END OF SECTION

**SECTION 23 3700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers:
 - 1. Rectangular ceiling diffusers.
 - 2. Round ceiling diffusers.
- B. Registers/grilles:
 - 1. Ceiling-mounted, egg crate exhaust and return register/grilles.
 - 2. Ceiling-mounted, exhaust and return register/grilles.
 - 3. Ceiling-mounted, supply diffusers.
 - 4. Wall-mounted, return register/grilles.
- C. Duct-mounted supply and return registers.
- D. Goosenecks.

1.02 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- B. SMACNA (ASMM) - Architectural Sheet Metal Manual.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Krueger-HVAC: www.krueger-hvac.com.
- B. Price Industries: www.price-hvac.com.
- C. Ruskin Company: www.ruskin.com.
- D. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com/.

2.02 SUPPLY AIR OUTLETS

- A. Type 'S2':
 - 1. Model: Titus OMNI-AA.
 - 2. Description: Aluminum - Square ceiling diffuser with round neck and plaque face. Back cone shall be one piece seamless construction and incorporate a round inlet collar of sufficient length for connecting, rigid or flexible duct.
 - 3. Diffuser shall integrate with all duct sizes shown on plans without affecting face size or appearance.
 - 4. Provide factory insulated R-6 foil backed insulation on outside of back cone.
 - 5. Border: Provide appropriate border to accommodate mounting per ceiling type.
 - 6. Ensure optimal performance to 30% of design air flow in VAV Systems.
 - 7. Finish: #26 White.
- B. Type 'S6':
 - 1. Model: Titus TMRA-AA.
 - 2. Description: Aluminum - Adjustable round ceiling diffuser.
 - 3. Uniform 360 degree discharge pattern. The discharge pattern can be adjusted in 3 fixed cone positions from horizontal to vertical throw.
 - 4. Border: Heavy extruded aluminum construction.
 - 5. Finish: #26 White.

- C. Type 'S8':
 - 1. Model: Titus CT-541.
 - 2. Description: Aluminum - Linear bar grille with 15 degree blades spaced at 1/2" on center. Outlet core shall have extruded aluminum receiving bar. Blades shall run parallel to long dimension of grille. The support and receiving bars shall not exceed 8" on center.
 - 3. Border: Grille border shall be heavy duty extruded aluminum construction with precise mitered corners and reinforcing support bars for extra support for the core receiving bar.
 - 4. Grille Finish: #26 White.

2.03 RETURN AIR INLETS

- A. Type 'R1':
 - 1. Model: Titus 50 F.
 - 2. Description: Aluminum 1/2"x1/2"x1" grids (egg crate core) with extruded aluminum border. Sized per schedule on drawings.
 - 3. Border: Type 3 for lay-in installation, Type 1 for surface mount. Panel mounting shall not be allowed.
 - 4. Provide with factory fabricated square to round adapter for connection to ductwork.
 - 5. Finish: #26 White.
- B. Type 'R3':
 - 1. Model: Titus 350 FL.
 - 2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
 - 3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Duct mounted.
 - 4. Finish: #26 White
- C. Type 'R4':
 - 1. Model: Titus 350 RL.
 - 2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
 - 3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Surface mount to side wall.
 - 4. Finish: #26 White.

2.04 EXHAUST AIR INLETS:

- A. Type 'E1':
 - 1. Model: Titus 350FL.
 - 2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
 - 3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Surface mount to ceiling.
 - 4. Finish: #26 White.
- B. Type 'E2':
 - 1. Model: Titus 50 F.
 - 2. Description: Aluminum 1/2"x1/2"x1" grids (egg crate core) with extruded aluminum border. Sized per schedule on drawings.
 - 3. Border: Type 3 for lay-in installation, Type 1 for surface mount. Panel mounting shall not be allowed.
 - 4. Provide with factory fabricated square to round adapter for connection to ductwork.
 - 5. Finish: #26 White.

2.05 GOOSENECKS

- A. Fabricate in accordance with SMACNA (DCS) of minimum 18 gage, 0.0598 inch galvanized steel.

- B. Goose neck duct to penetrate roof through a 18 inch high insulated roof curb. Provide curb cap and a weather tight boot to secure duct through curb cap to ensure water tight installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9123.

END OF SECTION

**SECTION 23 5100
BREECHINGS, CHIMNEYS, AND STACKS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Double wall metal stacks.

1.02 REFERENCE STANDARDS

- A. NFPA 54 - National Fuel Gas Code.
- B. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment.
- C. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- E. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances.
- F. UL 441 - Standard for Gas Vents.
- G. UL 959 - Medium Heat Appliance Factory Built Chimneys.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Lifetime Chimney Supply: www.lifetimechimneysupply.com
- B. DuraVent; DuraStack Pro (DIS2): www.duravent.com/#sle.
- C. Metal-Fab, Inc: www.mtlfab.com/#sle.
- D. Selkirk Corporation: www.selkirkcommercial.com/#sle.

2.02 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS

- A. Regulatory Requirements:
 - 1. Comply with applicable codes for installation of natural gas burning appliances and equipment.

2.03 DOUBLE WALL METAL STACKS

- A. Boiler venting shall be provided by boiler supplier to ensure venting system is coordinated with the boilers for proper functioning on boiler operation. Venting system shall include all draft control dampers and controls for a complete and operating system.
- B. Provide double wall metal stacks, tested to UL 103 and UL listed with positive pressure rating, for use with building heating equipment, in compliance with NFPA 211.
- C. Fabricate with 1 inch minimum air space between walls and construct inner liner of AL29-4C stainless steel and outer jacket of 304 stainless steel.
 - 1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.
- D. Accessories, UL labeled:

1. Wall Thimble: Designed for horizontal wall penetrations. Mounting plates with sleeve and pipe spacer.
2. Sidewall Exit Elbow: 45 Degree elbow down with Stainless Steel bird mesh across opening.
3. Drain Tee: Tee fitting for the bottom of risers with sloped bottom towards condensate drain plug.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54
- C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA (DCS) for equivalent duct support configuration and size.
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- F. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.
- G. Level and plumb chimney and stacks.
- H. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- I. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

END OF SECTION

**SECTION 23 5223
CONDENSING BOILERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Boilers.
- B. Controls, burner, and boiler trim.
- C. Hot water connections.
- D. Gas Train and piping to burner assemblies.
- E. Testing of Boilers/Burners.

1.02 RELATED REQUIREMENTS

- A. Section 23 2114 - Hydronic Specialties.
- B. Section 23 5100 - Breechings, Chimneys, and Stacks.

1.03 REFERENCE STANDARDS

1.04 ANSI Z21.13 - AMERICAN NATIONAL STANDARD FOR GAS-FIRED LOW-PRESSURE STEAM AND HOT WATER BOILERS.

- A. ASME (BPV IV) - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; The American Society of Mechanical Engineers; 2004.
- B. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2007.
- C. NFPA 54 - National Fuel Gas Code.
- D. UL 726 - Oil-Fired Boiler Assemblies; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- E. Part 4 of Title 12 Rules and Regulations of the State of New York Industrial Code Rule No. 4 (12NYCRR4).

1.05 PERFORMANCE REQUIREMENTS

- A. Boiler shall be capable of delivering full IBR gross output capacity at 100% firing rate.
- B. Rating:
 - 1. Scheduled capacities on Contract Drawings.

1.06 SUBMITTALS

- A. Product Data: Manufacturer's catalog sheets, specifications and installation instructions.
- B. Contract Closeout Submittals:
 - 1. Department of Labor Certification of Inspection: Deliver 2 copies to the Owner's Representative.
 - 2. Operation and Maintenance Data: Deliver 2 copies, covering the installed products to the Owner's Representative.
 - 3. Service Organization Data: Written notification from boiler manufacturer specifying the name, address, telephone number, and available service programs of fully equipped and authorized service organization.

1.07 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Boiler shall be constructed, tested and stamped in accordance with the ASME Code for Low Pressure Heating Boilers, and shall be IBR rated.
 - 2. Boiler shall comply with the requirements of Part 4 of Title 12 Rules and Regulations of the State of New York Industrial Code Rule No. 4 (12NYCRR4).
 - 3. Boiler shall comply with New York State Department of Environmental Conservation Law 6NYCRR, Parts 200, 201, 227 and 231.

- B. Certification: Affidavit by the Company Field Advisor, certifying that the boiler meets the contract requirements and is operating properly.
- C. Company Field Advisor: Secure the services of a Company Field Advisor for a minimum of working hours for the following:
 1. Render advice regarding installation and final adjustment of the boiler.
 2. Visit the Site upon completion of boiler to inspect the Work, and to notify the Owner's Representative of any Work which must be done or modified prior to NYS Department of Labor inspection.
 3. Witness final system test and then certify with an affidavit that the boiler is installed in accordance with the Contract Documents and is operating properly.
 4. Train facility personnel on the operation and maintenance of the system (minimum of two 4 hour sessions).
 5. Explain available service programs to facility supervisory personnel for their consideration.

1.08 WARRANTY

- A. Provide a ten-year warranty against defects in material and workmanship on cast iron boiler sections.
- B. Provide a five-year parts and labor warranty on burners.

PART 2 PRODUCTS

2.01 CAST IRON CONDENSING BOILERS

- A. Manufacturers
 1. HydroTherm KN-Series.
- B. Boiler Construction
 1. Combustion Chamber: The combustion chamber shall be constructed of cast-iron. An access door shall be provided for ease of service and inspection of the heat exchanger.
 2. Heat Exchanger: Boilers shall be a cast iron sectional unit designed for pressure firing and shall be constructed and tested for 100 P.S.I water working pressure, in accordance with the A.S.M.E. Section IV Rules for the Construction of Heating Boilers. Individual sections will have been subjected to a hydrostatic pressure test of 250 PSIG at the factory before shipment and they shall be marked, stamped or cast with the A.S.M.E. Code symbol. Boilers with less than 250-psi pressure test will not be acceptable for this project. The sections shall be of a down fired counter flow single-pass design. Water ports will be sealed with graphite port connectors. The sections will be fully machined for metal to metal sealing of the gas side surfaces. The design will provide for equal temperature rise through all sections. The heat exchanger shall be designed to prevent fluid boiling. The iron shall have a minimum thickness of ¼". The heat exchanger design should have no limitations on temperature rise or restrictions to inlet water temperature and a Cv of 100.
 3. Jackets: Stainless Steel
 4. Gas Burner: The burner shall be constructed of a reticulated Corderite Ceramic. The burner flame shall burn horizontally and be of the pre-mix type with a forced draft fan. Burner shall fire to provide equal distribution of heat throughout the entire heat exchanger. The burner shall be easily removed for maintenance without the disruption of any other major component of the boiler. A window view port shall be provided for visual inspection of the boiler during firing. The gas distribution components and burner shall be enclosed with a cast-aluminum housing.
 5. Ignition components: The ignition hardware shall consist of Alumina ceramic insulated ignition electrodes and UV sensing tube permanently arranged to ensure proper ignition electrode and UV alignment
 6. Rated Capacity: The boiler shall be capable of operating at rated capacity with pressures as low as 2" W.C. at the inlet to the burner pressure regulator.
 7. The burner shall be capable of 98.3% efficiency without exceeding a Nox reading above 30ppm.
 8. The burner and gas train shall be provided with the following trim and features:
 - a. Burner Firing: Full modulation with 5:1 turndown @ Continuous CO2
 - b. Burner Ignition: Intermittent spark
 - c. Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, and allow gas valve to open.

- d. Flue-Gas Collector: Enclosed combustion chamber with integral combustion-air blower and single venting connection.
 - e. Gas Train: Lubricated manual gas valves (2), main gas valve (solenoid), 'B' valve, pilot gas pressure regulator, and automatic pilot gas valve. All components to be factory mounted.
 - f. Safety Devices: High/Low gas pressure switches, air-flow switch, and blocked flue detection switch, low water cutoff (manual reset). All safeties to be factory mounted.
- C. Boiler Design
- 1. Design: Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for a minimum of 5:1 continuous turn down with constant CO₂ over the turndown range. The boiler shall operate with natural gas or propane and have an AFA certified input rating as noted on the drawings, and a thermal efficiency rating of 86% at rated input and 98.3% at minimum input. The boiler shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The boiler will automatically adjust input for altitude and temperature induced changes in air density. The boiler will use a proven pilot interrupted spark ignition system. The boiler shall use a UL approved flame safeguard ignition control system using UV detection flame sensing. The UV detector shall be air cooled to prevent condensate formation and so designed as to prevent misalignment. The design shall provide for silent burner ignition and operation. The boiler shall be down fired counter flow such that formed condensate always moves toward a cooler zone to prevent re-evaporation. An aluminum corrosion resistant condensate drain designed to prevent pooling and accessible condensate trap shall be provided. Boiler shall be able to vent a horizontal distance of 80 equivalent feet.
 - 2. Service Access: The boilers shall be provided with access covers for easily accessing all serviceable components. The boilers shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All accesses must seal completely as not to disrupt the sealed combustion process. All gas train components and blower motor must be accessible and able to adjust without the removal of a single covers or cabinet components.
 - 3. Indicating lights: Each boiler shall include a diagnostic control panel with a full text display indicating power on, operator, high limit, low water, low air the condition of all interlocks and the BTUH input percentage., trial for ignition, main burner, flame failure, and inlet/outlet temperatures incorporated into the boiler. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.
- D. Water Boiler Trim:
- 1. ASME relief valve, 50 PSI.
 - 2. Combination water pressure and temperature shipped factory installed. LCD inlet/outlet temperature gauges to be an integral part of the front boiler control panel to allow for consistent easy monitoring of temperatures factory mounted and wired.
 - 3. Temperature control with manual-reset limits boiler water temperature in series with the operating control. High Limit shall be factory mounted and sense the outlet temperature of the boiler through a dry well.
 - 4. Boiler shall be provided with a Honeywell RM7896C series digital flame safe guard. The flame safe guard shall be capable of both pre and post purge cycles.
 - 5. Each boiler shall incorporate a electric type low water level cutoff with test and manual reset and dual over-temperature protection with manual reset in accordance with ASME section IV and CSD-1. Remote fault alarm contacts, sensor failure detection and boiler status and failure annunciator shall be standard equipment.
 - 6. Provide secondary low water level cutoff with manual reset.
- E. Standard Trim:
- 1. Aluminum Condensate Receiver Pan
 - 2. Low Air Pressure Switch
 - 3. Blocked Flue Detection Switch
 - 4. Flow Switch (Factory Mounted and wired)
 - 5. Modulation Control
 - 6. Temperature/Pressure Gauge
 - 7. Manual Reset High Limit

8. Air Inlet Filter
9. Inlet/Outlet Temperature Display
10. Full Digital Text Display for all Boiler Series of Operation and Failures
11. Variable Frequency Drive and Combustion Air Fan
12. Air Inlet hood for exterior termination of air intake pipe. (shipped loose)
13. Vent termination Hood for exterior termination of vent pipe. (shipped loose)
14. FM or IRI controls and Gas Train
15. Condensate Drain

F. Warranty

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

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install boiler in accordance with manufacturer's printed instructions.
- B. Install boiler on concrete housekeeping base, sized minimum 4 inches larger than boiler base. Refer to Section 03 3000. Arrange to allow sufficient room for cleaning and servicing all components.
- C. Provide framed glass holder for NYS Department of Labor certificate of inspection, and post near the boiler prior to operation of the boiler.
- D. Attach to boiler, identification number assigned by NYS Department of Labor Commissioner.
- E. Provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.
- F. Provide hydronic piping connections and accessories as indicated.
- G. Provide breeching and chimney connections as indicated.
- H. Provide air intake and exhaust piping, size and type as recommended by the manufacturer
- I. Pipe relief valves to nearest floor drain.
- J. Provide boiler manufacturer recommended manifold pipe and fittings from each boiler to the nearest floor drain or as indicated.
- K. Coordinate electrical connections with Division 26.

3.02 FIELD QUALITY CONTROL

- A. Preliminary Requirements:
 1. Employ the services of Company Field Advisor to complete duties specified in Quality Assurance Article.
- B. Boiler Start Up:
 1. Arrange with NYS Department of Labor for inspection of boiler upon completion of installation.
 - a. Do not operate boiler until NYS Department of Labor inspection is made and a Certificate of Inspection is posted.
 - b. Pay application and inspection fees required by NYS Department of Labor.
 - c. Prepare boiler for internal inspection or hydrostatic pressure test on the date specified by the Department of Labor inspector.
 - 1) Remove handhole plates, and washout plugs in the water column connection.
 - 2) Remove as directed by the NYS Department of Labor inspector, brick work and insulation.
 - 3) Remove gages for testing if required by NYS Department of Labor inspector.

- 4) Stop leaks of steam or hot water into the boiler being inspected from the other components.
 - 5) Make available to the NYS Department of Labor inspector a competent person to be placed under the inspector's supervision to disassemble, reassemble, test, adjust, operate or forcible handling any part of the boiler.
2. Preliminary System Tests:
 - a. Preparation: After the State Department of Labor Certificate of Inspection has been posted, fire the boiler for the purpose of checking general operation, proving mechanical and electrical controls, and making necessary adjustments. Operate the system long enough to assure that it is performing properly.
 - b. Run preliminary test for the purpose of:
 - 1) Determining whether the boiler and appurtenances are in suitable condition to conduct the acceptance test.
 - 2) Checking the adjusting equipment.
 - 3) Training Facility personnel.
 3. System Acceptance Test:
 - a. Preparation: Notify the Owner's Representative at least 3 working days prior to the test so arrangements can be made to have a Facility Representative witness the test.
 - b. Make the following tests:
 - 1) Operate boiler, appurtenances, and fine tune adjustable devices.
 - 2) Test alarm indicating devices.
 - 3) Operate for a sufficient period of time to demonstrate satisfactory overall performance of the heating system.
 - c. Supply equipment necessary for system adjustment and testing.
 - d. Submit a typewritten report of the test results, signed by the Company Field Advisor and the Owner's Representative. Enclose a copy of the report in a metal frame covered with plastic sheet glazing and mount it adjacent to the control panel.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer's field representative for starting unit and training operator. Provide written report of start-up to Owner's Representative.

END OF SECTION

SECTION 23 6213
PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSER UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Condensing unit package.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Refrigerant piping connections.
- E. Motor starters.

1.02 RELATED REQUIREMENTS

- A. Section 23 2300 - Refrigerant Piping.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems.
- B. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams. Include equipment served by condensing units in submittal, or submit at same time, to ensure capacities are complementary.
- C. Design Data: Indicate pipe and equipment sizing.
- D. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide a five year warranty to include coverage for refrigerant compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Daikin Applied.
- B. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
- C. York International Corporation/Johnson Controls, Inc: www.york.com/#sle.

2.02 MANUFACTURED UNITS

- A. Units: Self-contained, packaged, factory assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, wind deflector, and screens.
- B. Construction and Ratings: In accordance with AHRI 210/240. Test in accordance with ASHRAE Std 23.1.

- C. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1.
- D. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.03 CASING

- A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.
- B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.

2.04 CONDENSER COILS

- A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig, and vacuum dehydrate. Seal with holding charge of nitrogen.
- B. Coil Guard: Expanded metal with lint screens.

2.05 FANS AND MOTORS

- A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Equip with roller or ball bearings with grease fittings extended to outside of casing.
- B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in current and thermal overload protection.

2.06 COMPRESSORS

- A. Compressor: Semi-hermetic reciprocating type.
- B. Mounting: Statically and dynamically balance rotating parts and mount on spring vibration isolators.
- C. Lubrication System: Reversible, positive displacement oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.
- D. Capacity Reduction Equipment: Suction valve unloaders, with lifting mechanism operated by electrically actuated solenoid valve, with unloaded compressor start; controlled from room thermostat. Provide hot gas bypass where indicated.

2.07 REFRIGERANT CIRCUIT

- A. Provide each unit with quantity of refrigerant circuits as indicated in equipment schedule. , factory supplied and piped. Refer to Section 23 2300.
- B. For each refrigerant circuit, provide:
 1. Filter dryer replaceable core type.
 2. Liquid line sight glass and moisture indicator.
 3. Thermal expansion valve for maximum operating pressure.
 4. Insulated suction line.
 5. Suction and liquid line service valves and gauge ports.
 6. Liquid line solenoid valve.
 7. Charging valve.
 8. Discharge line check valve.
 9. Compressor discharge service valve.
 10. Condenser pressure relief valve.
- C. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.

2.08 CONTROLS

- A. On unit, mount weatherproof steel control panel, NEMA 250, containing power and control wiring, molded case disconnect switch, factory wired with single point power connection.
- B. Provide safety controls arranged so any one will shut down machine:

1. High discharge pressure switch (manual reset) for each compressor.
 2. Low suction pressure switch (automatic reset) for each compressor.
 3. Oil Pressure switch (manual reset).
- C. Provide the following operating controls:
1. Refer to Section 23 0923
- D. Provide controls to permit operation down to 0 degrees F ambient temperature.
- E. Gauges: Piped for suction and discharge refrigerant pressures and oil pressure for each compressor.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.
- C. Provide connection to refrigeration piping system and evaporators. Refer to Section 23 2300. Comply with ASHRAE Std 15.

3.02 SYSTEM STARTUP

- A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.
- B. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.
- C. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.
- D. Provide cooling season start-up, and winter season shut-down for first year of operation.

END OF SECTION

**SECTION 23 7313
AIR HANDLING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Access section.
- B. Air handling units.

1.02 RELATED REQUIREMENTS

- A. Section 23 3100 - Ductwork.
- B. Section 23 3300 - Ductwork Accessories.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. AHRI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment.
- D. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- E. AHRI 430 (I-P) - Performance Rating of Central Station Air-handling Unit Supply Fans.
- F. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- H. NEMA MG 1 - Motors and Generators.
- I. NFPA 90 A & B - Installation of Air Conditioning and Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems.
- J. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- K. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's catalog sheets and drawings showing overall dimensions of complete assembly including clearance and access requirements, performance charts, sound power data, specifications, operating weights and support requirements, and installation instructions for each air handling unit.
 - a. Indicate shipping split locations, dimensions, and weights.
 - b. Indicate filter assembly and data for filter media and performance.
 - c. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- B. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products to the Owner's Representative.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Filters: One set for each unit.
 - 3. Box and label filters, label belts. Store at site where directed by Owner's Representative.

1.05 QUALITY ASSURANCE

- A. NFPA Compliance
 - 1. Comply with applicable provisions NPFA 70 pertaining to construction and installation of electrically operated components of packaged air handling units.
- B. Flame-Smoke Ratings

1. Except as otherwise indicated, provide air handling unit thermal insulation with flame-spread rating of 25 or less, fuel-contributed of 50 or less, and smoke developed rating of 50 or less.
- C. AMCA Standards
 1. Comply with Air Movement and Control Association Standards as applicable to testing and rating fans, and testing louvers, dampers, and shutters.
- D. Damper Air Leakage Rate
 1. Except where more stringent limitation is indicated, provide dampers with leakage limited to 6 CFM per square foot at 4" static pressure differential.
- E. SMACNA Compliance
 1. Comply with Sheet Metal and Air Conditioning Contractors National Association ductwork construction standards as applicable to air handling units.
- F. Industry Standards
 1. Except as otherwise indicated, comply with ASHRAE recommendations pertaining to packaged air handling units.
- G. ARI Certification
 1. Provide central station packaged air handling units which comply with Air Conditioning and Refrigeration Institute Standard 430 and display ARI's certification symbols.
- H. UL Compliance
 1. Provide electric components for air handling units which have been listed and labeled by Underwriters' Laboratories.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Each section shall have lifting lugs or shipping skid to allow for field rigging and final placement of section.
- C. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.

1.07 WARRANTY

- A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

1.08 START-UP AND OPERATING REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 AIR HANDLING UNITS

- A. Manufacturers:
 1. Daikin Applied: www.daikinapplied.com/#sle.
 2. Trane Inc: www.trane.com/#sle
 3. York International Corporation / Johnson Controls Inc: www.york.com/#sle.
- B. General:
 1. Provide factory built and tested modular air handling units designed for indoor installation, of sizes, configuration, and capacities as shown on contract drawings and specified herein.
 2. Provide unit mounting legs to support all sections of unit and raise unit for proper condensate trapping. Contractor shall verify with unit manufacturer that mounting legs are of sufficient height to properly trap unit. Contractor shall be responsible for providing a concrete housekeeping pad if unit is not provided with sufficient height mounting legs.

C. Casing:

1. Construction: Fabricate on complete channel frame and drain pan with removable panels secured by mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gaskets. Gaskets shall be applied at the factory. Sections shall be bolted together.
 - a. Outside Casing:
 - 1) G90 Galvanized Steel: 0.0500 inch (18 USS gauge) with two(2) coats of electrostatic powder coating, oven baked.
 - b. Inside Casing:
 - 1) G90 Galvanized Steel: Solid, 0.0312 inch (22 USS gauge) with two(2) coats of electrostatic powder coating, oven baked.
 - c. Floor Plate:
 - 1) G90 Galvanized Steel: Solid, 0.0375 inch (20 USS gauge)
2. Leakage: Casing leakage rate shall not exceed 0.5 cfm per square foot of cabinet area at 5 inch water gage static pressure.
3. Structural Integrity: Construct unit casing sections capable of operating from -4 inch to +6 inch water gage with maximum deflection not exceeding L/240 at 5 inches water gage positive or negative static pressure.
4. Finish: Casing finish shall meet ASTM B 117 250 hour salt spray test.
5. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B and weld pins .
 - a. Materials: ASTM C 1071 with coated surface exposed to air stream to prevent erosion of glass fibers.
 - b. Thickness: 2" thick with expandable poly-iso foam.
 - c. "R" value: 11.0 at 75 deg F temperature.
 - d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 916.
 - e. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916
 - f. Location and Application: Encased between outside and inside casing.
6. Access Panels and Doors: Same materials and finishes as cabinet (interior and exterior), complete with hinges, latches, handles, and gaskets. Access panels and doors shall be sized and located to allow periodic maintenance and inspections as shown on these drawings. Provide access panels and doors in the following locations:
 - a. Fan Section: Hinged access door.
 - b. Access Section: Hinged access doors.
 - c. Coil Section: Inspection panel.
 - d. Mixing Box / Damper Section: Hinged access door.
 - e. Filter Section: Hinged access door, to allow periodic removal and installation of filters.
7. Condensate Drain Pans: Formed sections of stainless steel insulated, sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling coils (included coil piping connections and return bend) and humidifier when units are operating at maximum cataloged face velocity across cooling coil.
 - a. Double-Wall Construction: Fill space between walls with 3#/cu.ft. Density foam insulation and seal moisture tight.
 - b. Drain Connections: Both ends of the pan.
 - c. Pan-Top Coating: Elastomeric compound.
 - d. Units with stacked coil shall have an intermediate drain pan or drain trough to collect condensate from top coil.

D. Fan Section

1. 1.Fan-Section Construction: Direct drive SWSI Plenum fans consisting of Fan wheel, motor and disconnect switch, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels.
 - a. Mount fan with 1" open type spring vibration isolation.
 - b. Provide perforated inner liner in fan sections.

2. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housing with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.
 - a. Panel Bracing: Steel angle or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - b. Performance Class: AMCA 99-2408, Class as required.
 3. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.
 4. Airfoil-Fan Wheels: Steel construction with smooth-curved inlet flange, heavy backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron hub riveted to backplate and fastened to shaft with set screws.
 5. Vibration Control: Install fans on 1" open type spring vibration isolation.
 6. Fan-Section Quality Control:
 - a. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
 - b. Factory test fans performance for flow rate, pressure, power, air density, rotation, speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
 7. Flexible Duct Connections: For separating fan and coil, and adjacent sections; refer to Section 23 3300.
- E. Motors
1. Motors shall be premium efficient E+ with class B insulation
 2. Motor wiring shall be brought back to control panel located at the external on the external casing of the unit.
 3. Units will be provided with variable speed drives on motors. See "Specification 238505 Variable Speed Drive System" for further details.
 4. Units will be provided with single point electrical connection with integral disconnect.
- F. COIL SECTION
1. Coils shall be manufactured from seamless copper tubing, 0.025" wall thickness, 5/8" diameter tubing, and tested at 450psi air pressure under water.
 2. Coil Sections: Common or individual, insulated, galvanized-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils. Retain one of three options listed below:
 - a. Hot water coils Self-draining coils
 - 1) Coils to have face and bypass dampers for freeze protection sequence
 - 2) Arrangement: Horizontal coils
 - 3) Piping Connections: Threaded
 - 4) Tubes: Copper with minimum wall thickness of 0.025"
 - 5) Fins Aluminum with 0.0075" thickness
 - 6) Fin and Tube Joint: Silver brazed
 - 7) Headers: Cast iron or copper with vents and drainable connection
 - 8) Ratings: Design tested and rated according to ASHRAE 33 and ARI 410
 - 9) Working-Pressure Ratings: 150psig
 - 10) Source Quality Control: Test to 450psig
 - 11) Coil grommet - Where coil connections extend through the unit casing, a double grommet system shall be used to prevent air leakage. Maximum air leakage shall be no more than 25 CFM @ 3.0" W.C.
 - b. Refrigerant Coils: Coil designed for use with R-410 refrigerant, fabricated according to ARI 410, connected with brazed fittings.
 - 1) Capacity Reduction: Circuit for intertwined control.
 - (a) Tubes: Copper, minimum wall thickness of .025"
 - (b) Fins: Aluminum with .0075" thickness
 - (c) Fin and Tube Joint: Silver brazed

- (d) Suction and Distributor: Seamless copper tube with brazed joints.
 - (e) Frames: Galvanized-steel channel frame.
 - (f) Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
 - (g) Working-Pressure Rating: 300 psig
 - (h) Source Quality Control: Test to 450psig
3. Coils shall be certified in accordance with ARI 410 and bear the ARI label.
 4. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within the unit casing ensuring that if condensate forms on the header or return bends it is captured by the drain pan under the coil. Coils shall be removable from unit casing through access panels without the need to disassemble the entire section from the unit. with blank off sheets and sealing collars at connection penetrations Fabricate casing from galvanized steel. Heating coils shall be furnished uncased and slide into a track to allow thermal movement.
- G. ACCESS SECTION
1. Provide where indicated on drawings to allow for inspection, cleaning, and maintenance of field-installed components.
 2. Construct access doors same as previously specified within this Section.
- H. Filters:
1. Filters: Comply with NFPA 90A.
 2. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.
 3. Extended-Surface, Disposable Panel Filters: Factory-fabricated, dry, extended-surface filters with holding frames.
 - a. Media: Fibrous material formed into deep-V -shaped pleats and held by self-supporting wire grid or slide in track.
 - b. Filters shall have a minimum MERV-14 rating.
- I. Dampers:
1. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 3% of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
 2. Damper Operators: Electric specified in Division 23 Section "Direct-Digital Control System for HVAC".
 3. Low-Leakage Dampers: All dampers are to made of rigid aluminum frame with multi airfoil aluminum blades so as to reduce pressure drop and sound generated air. Opposed blade dampers rotation is achieved by PVC gears.
- J. Mixing Box:
1. Where required units will be provided with mixing boxes. Mixing boxes will be provided with factory installed low leakage gear driven dampers. (Actuators will be provided by controls contractor) See damper requirements.
- K. Electrical Requirements:
1. Units will be provided with a single point power connection.
 2. Units will be provided with integral disconnect switch for ease of maintenance.
 3. Units will be provided with GFCI convenience receptacle.
- L. CONTROLS
1. Controls will be by Temperature Controls Contractor.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in strict accordance with manufacturer's written instructions.
- B. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

- C. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- D. Provide adjustable sheaves required for final air balance.
- E. Make connections to coils with unions or flanges.

END OF SECTION

**SECTION 23 7413
PACKAGED ROOF-TOP UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged roof top unit.
- B. Unit operating controls.
- C. Roof mounting curb and base.
- D. Electrical power connections.
- E. Operation and maintenance service.

1.02 RELATED SECTIONS

- A. Section 23 0553 - Mechanical Identification.
- B. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- C. Section 23 0713 - Ductwork Insulation.
- D. Section 23 3100 - Ductwork.
- E. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment.
- C. ARI 360 - Commercial and Industrial Unitary Air Conditioning Equipment testing and rating standard.
- D. ARI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment.
- E. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- F. ANSI/ASHRAE 37 - Testing Unitary Air Conditioning and Heat Pump Equipment.
- G. ANSI/ASHRAE 90.1-2004 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.
- H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- I. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; 2002.
- J. UL 1995 - Heating and Cooling Equipment; Underwriters Laboratories Inc.; 2005.

1.04 SUBMITTALS

- A. Shop Drawings: Submit shop drawings indicating overall dimensions as well as installation, operation, and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation, and operating weights. Include shop drawings for each size of factory fabricated roof curb.
- B. Product Data: Manufacturer's catalog sheets, brochures, performance charts, standard schematic drawings, specifications, and installation instructions for each size unit. Include specifications for all options and accessories.
- C. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Owner's Representative.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Unit shall conform to ANSI Z21.47/UL1995 for construction of packaged air conditioners.

2. Unit shall be factory tested, with design, construction and installation in accordance with the following: ARI Standard 210, NFPA, UL, ASHRAE 15 Safety Code for Mechanical Refrigeration, and all State or Local codes or regulations having jurisdiction.
3. Rate cooling capacities in accordance with ARI Standard 210.
4. Electrical components shall be UL listed.

1.06 WARRANTY

- A. Provide a full parts and labor warranty for one year from start-up or 18 months from shipment, whichever occurs first.
- B. Provide a five year manufacturer's warranty to include parts coverage for refrigeration compressors.
- C. Provide a ten year manufacturer's warranty to include parts coverage for heat exchangers.

PART 2 PRODUCTS

2.01 PACKAGED ROOF-TOP UNITS

- A. Manufacturers:
 1. Daikin Applied
 2. The Trane Company.
 3. Aeon.
- B. General Description:
 1. Furnish as shown on plans, Daikin Applied Rebel Single zone Heating and Cooling Unit(s) model DPSH and DAHA. Unit performance and electrical characteristics shall be per the job schedule.
 2. Configuration: Fabricate as detailed on prints and drawings:
 - a. Return plenum / economizer section
 - b. Filter section
 - c. Heat Pump Heating/Cooling coil section
 - d. Auxiliary Glycol Heating coil section
 - e. Supply fan section
 - f. Heat recovery section
 - g. Condensing Heat Pump unit section
 3. The complete unit shall be cETLus listed.
 4. The unit shall be ASHRAE 90.1-2016 compliant and labeled.
 5. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.
 6. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
 7. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
 8. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
 9. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.
- C. Cabinet, Casing, and Frame:
 1. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.

2. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
 3. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
 4. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.
- D. Outdoor / Return Air Section:
1. Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.
 2. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.
 3. Daikin Applied UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.
 4. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when when supply fan starts, and close when supply fan stops.
- E. Energy Recovery: (Does not include RTU-1,2,6,7,8A,9A)
1. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
 2. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. 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 Heat Exchangers For Energy Recovery Ventilation Equipment.
 3. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.

4. The unit shall have 2" Merv 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.
5. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
6. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
7. Wheels 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.
8. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.
9. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed.
10. The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.
11. When the outside air is below 32F (adjustable) the bypass damper will open for 5 minutes (adjustable) every 60 minute period (adjustable). Exhaust air continues to run though the core during this time to remove frost buildup.
12. The ERV core shall transfer both sensible and latent energy between the incoming fresh air stream and the exhaust stale air stream.
13. E. The ERV core shall be in either a cross-flow or counter cross-flow orientation and have no moving parts.
14. The ERV core shall be certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. Products not currently AHRI certified will not be accepted.
15. The ERV core shall achieve the minimum effectiveness value as indicated in the schedule.
16. The fresh air stream must have complete separation from the stale air stream to prevent cross contamination.
17. The ERV core shall have Exhaust Air Transport Ratio of 0.5% as tested to AHRI 1060 (EATR) to prevent cross-over of gases, contaminants or odors.
18. The ERV core's Outdoor Air Correction Factor (OACF) shall not exceed 1.0 as tested to AHRI 1060 (OACF) Standard.
19. The ERV core shall not be degraded or promote the growth of mold and bacteria with a rating of zero in testing according to ISO846 A and C.
20. The ERV core must be able to tolerate freezing temperatures of -30°C (-22°F and not have an increase in EATR or decrease in performance after being frozen.
21. The ERV core must be able to tolerate high temperatures of +60°C and not have an increase in EATR or decrease in performance at these elevated temperatures.
22. The ERV core must be freeze tolerant tested to 40 freeze thaw cycles from -20°C to +20°C while maintaining the energy recovery effectiveness and EATR rating of 0.5%.
23. The ERV core must be water washable to remove dust and contaminants.

24. The ERV core must be flame proof and comply with UL 723 with a flame spread index that shall not be over 25 and a smoke index that shall not be over 50.
 25. The ERV cores should have particulate filters positioned before the incoming air streams.
 26. Accepted manufacturer: CORE Energy Recovery Solutions or approved equal, subject to compliance with requirements
- F. Exhaust Fan:
1. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
 2. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
 3. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.
- G. Filters:
1. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 and 4" MERV 14 filters.
- H. Heat Pump Heating/Cooling Coil: (Does not include RTU-3A,4A,5A)
1. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
 2. The direct expansion (DX) heating/cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
 3. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
 4. Provide a reversing valve for heat pump operation.
 5. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
 6. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.
- I. Hot Gas Reheat: (Does not include RTU-3A,4A,5A)
1. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser
 2. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.
 3. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
 4. Each coil shall be factory leak tested with high-pressure air under water.
- J. Supply Fan:

1. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
 2. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1" spring isolators.
 3. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
 4. Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
 5. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
 6. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.
- K. Auxilary Glycol Heating coil: (40% Propylene)
1. Glycol heating coil shall be factory installed in the heat section. The glycol heat section shall be installed downstream of the supply air fan. A factory-tested diffuser shall be used in order to provide air distribution across the coil. The rooftop unit shall include a piping vestibule to allow piping to penetrate roof within the unit roof curb. The coil connection shall terminate in the vestibule. All coil connections shall be copper, steel connections shall not be allowed in order to prevent dielectrics and corrosion.
 2. Coils shall be fabricated of seamless 3/8" diameter copper tubing that is mechanically expanded into high efficiency rippled and corrugated aluminum plate fins. All coil vents and drains shall be factory installed. Glycol coil shall be fully cased to allow for easy replacement.
- L. Condensing Heat Pump Section: (Does not include RTU-3A,4A,5A)
1. Outdoor coils shall have seamless copper tubes, mechanically bonded into aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
 2. Outdoor air coils shall be protected from incidental contact to coil fins by a coil guard. Coil guard shall be constructed of cross wire welded steel with PVC coating.
 3. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 25~120°F. Mechanical cooling shall be provided to 25° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
 4. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite materia
 5. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line. A refrigeration capacity-control device will not be accepted as an equal to inverter scroll compressors
 6. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
 7. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

M. Electrical:

1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
2. A GFI receptacle shall be unit mounted that is field powered.
3. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

N. Controls:

1. Provide a microprocessor based system to control all refrigeration functions including compressor speed, condenser fan function, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall operate the unit at peak efficiency utilizing variable head pressure control and electronic expansion valve while maintaining the cooling, or heating in heat pump operation, call per third party control. The microprocessor control shall consist of only direct expansion required temperature sensors, pressure sensors, controller and keypad/display operator interface. Refrigeration sensors and controller shall be factory mounted, wired and tested.
2. The microprocessor controls shall be solely dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. No commissioning settings shall be lost, even during extended power shutdowns
3. The microprocessor controls shall be dependent on starting and stopping of the unit via terminal strip control and logic. The control system shall be capable of providing a remote alarm indication. The microprocessor shall provide compressor capacity & status, defrost status (heat pump only), condensate overflow alarm, and dirty filter alarm.
4. All digital and analog inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
5. The keypad interface shall allow convenient navigation and access to the commissioning functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
 - a. Supply and exhaust fan speed control.
 - b. Refrigeration alarm details.

O. Roof Curb:

1. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 18" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.
2. Where called out on plans the unit shall be provided with a fully insulated plenum curb to allow existing duct penetrations to work with the configuration of the new units. The supply air and return/exhaust air streams shall not mix within the curb.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Roof Curbs: Furnish roof curbs to Roofing/General Contractor for installation.
- B. Install packaged units on roof curbs in complete accordance with the manufacturer's printed instructions and as indicated.
- C. Provide all piping, electrical, and ductwork connections to units through factory furnished and installed, or factory furnished and field installed through the base openings.
- D. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

3.03 SYSTEM STARTUP

- A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstrate operation to Owner's maintenance personnel.

3.05 MAINTENANCE

- A. Provide two separate service offerings (spring and fall) for preventive service and maintenance (in addition to start-up of systems) of packaged roof top units.
 - 1. Furnish the following Cooling Cycle service and maintenance of package for the roof top units during the Spring period within one year from Date of Substantial Completion, including but not limited to the following:
 - a. Report in with the Customer Representative
 - b. Record and report abnormal conditions, measurements taken, etc.
 - c. Review customer logs with the customer for operational problems and trends.
 - d. General Assembly Inspection
 - 1) Inspect for leaks and report leak check results.
 - 2) Repair minor leaks as required (e.g. valve packing, flare nuts).
 - 3) Calculate refrigerant loss rate and report to the customer.
 - 4) Check the sheaves and pulleys for wear and alignment.
 - 5) Check the belts for tension, wear, cracks, and/or glazing.
 - 6) Verify proper damper operation.
 - 7) Check mechanical linkages for wear, tightness, and clearances.
 - 8) Verify clean condenser and evaporator.
 - 9) Verify clean evaporator fan.
 - 10) Verify clean air filters.
 - 11) Verify the operation of the crankcase oil heater(s), if applicable.
 - e. Controls and Safeties Inspection
 - 1) Verify the operation of the discharge air temperature control device, if applicable.
 - 2) Verify the operation of the outside air temperature control device.
 - 3) Verify the operation of the mixed air temperature control device.
 - 4) Test the operation of the high condenser pressure safety device. Calibrate, if necessary, and record setting.
 - 5) Test the operation of the low temperature safety device. Calibrate, if necessary, and record setting.
 - 6) Test the operation of the low pressure safety device(s). Calibrate, if necessary, and record setting.

- f. Lubrication
 - 1) Lubricate motor bearings, if applicable.
 - 2) Lubricate fan bearings.
 - 3) Check oil level in the compressor(s), if applicable.
 - g. Motor and Starter
 - 1) Clean the starter and cabinet.
 - 2) Inspect wiring and connections for tightness and signs of overheating and discoloration.
 - 3) Check the contactors for free and smooth operation.
 - 4) Meg the compressor motor(s) and record readings.
 - 5) Verify the tightness of the compressor motor terminal connections.
 - 6) Verify the operation of the crankcase oil heater(s), if applicable.
 - h. Startup and Checkout Procedure
 - 1) Start the unit.
 - 2) Verify the starter operation.
 - 3) Verify the smooth operation of the compressors and fans.
 - 4) Log operating conditions of the unit after the system has stabilized.
 - 5) Review operating procedures with operating personnel.
 - 6) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.
 - i. Provide written report to Owner.
2. Furnish the following Heating Cycle service and maintenance of package for the roof top units during the Fall period within one year from Date of Substantial Completion, including but not limited to the following:
- a. Perform the heating inspection/maintenance procedure applicable to the unit (steam/hot water, electric, gas).
 - b. Verify smooth operation of the fans.
 - c. Check the belts for tension, wear, cracks, and glazing.
 - d. Verify clean air filters.
 - e. Provide written report to Owner.

END OF SECTION

**SECTION 23 8200
CONVECTION HEATING AND COOLING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Finned tube radiation.
- B. Unit ventilators.

1.02 RELATED REQUIREMENTS

- A. Section 23 0716 - HVAC Equipment Insulation.
- B. Section 23 0719 - HVAC Piping Insulation.
- C. Section 23 2113 - Hydronic Piping.
- D. Section 23 2114 - Hydronic Specialties.
- E. Section 23 2300 - Refrigerant Piping.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

1.05 WARRANTY

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

PART 2 PRODUCTS

2.01 HYDRONIC FINNED TUBE RADIATION

- A. Manufacturers:
 - 1. Sterling Hydronics Corporation: www.sterlinghydronics.com.
 - 2. Slant/Fin Corporation: www.slantfin.com/#sle.
 - 3. Zehnder Rittling: www.rittling.com/#sle.
- B. Required Directory Listing: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
- C. Heating Elements: 3/4 inch ID seamless copper tubing, mechanically expanded into evenly spaced aluminum fins sized 4 by 4 inches, suitable for soldered fittings.
- D. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- E. Enclosures: 18 gage, 0.0478 inch sheet steel up to 18 inches in height, 16 gage, 0.0598 inch sheet steel over 18 inches in height or aluminum as detailed, with easily jointed components for wall to wall installation.
- F. Finish: Factory applied baked primer coat.
- G. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
- H. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

2.02 UNIT VENTILATORS

- A. Manufacturers:
 - 1. Daikin Applied: www.daikinapplied.com/#sle.
 - 2. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
- B. Performance Data and Safety Requirements:
 - 1. Unit capacities certified and tested in accordance with AHRI 840 and AHRI 350.
 - 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
- C. Required Directory Listings: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
- D. Hydronic Coils:
 - 1. Copper tubes mechanically expanded or bonded into evenly spaced aluminum fins.
 - 2. Provide insulated drain pan under heating coils, to prevent sweating, with field convertible left or right hand drain connections.
- E. Refrigerant Coils:
 - 1. Provide factory installed thermal expansion valves, properly sized to accommodate the selected condensing unit.
 - 2. Factory proof and leak tested to ensure leak tight operation.
 - 3. Provide insulated drain pan, to prevent condensation, with field convertible left or right hand connections.
- F. Cabinet: 14 gage, 0.0747 inch sheet steel on solid base pan with exposed edges rounded. Provide removable front panels with quick-acting, key-operated cam locks. Provide removable die-cast or fabricated steel discharge grilles. For units having cooling coils, insulate internal parts and surfaces exposed to conditioned air stream with moisture resistant insulation.
- G. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- H. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven, arranged to draw air through coil.
- I. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- J. Controls:
 - 1. Unit Ventilator Manufacturer's Controls:
 - a. Fan speed switch for unit mounting.
 - b. Disconnect switch.
- K. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before coil.
- L. Mixing Dampers: Multi-blade with compressible seal, capable of varying proportion of mixed air from 100 percent room air to 100 percent outside air.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Finned Tube Radiation:
 - 1. Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated.
 - 2. Center elements under window with elements of equal length centered under each window for multiple windows.
 - 3. Install wall angles and end caps where units butt against walls.

- D. Unit Ventilators:
 - 1. Locate as indicated, level and shim units, and anchor to structure.
 - 2. Coordinate exact location of wall louvers.
 - 3. Provide wall trim pieces for continuous wall-to-wall installation.
- E. Units with Hydronic Coils:
 - 1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.
- F. Units with Cooling Coils: Connect drain pan to condensate drain.

3.03 FIELD QUALITY CONTROL

- A. Provide manufacturer's field representative to test, inspect, instruct, and observe.

3.04 CLEANING

- A. After construction and painting is completed, clean exposed surfaces of units.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
- C. Install new filters.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

END OF SECTION

**SECTION 23 8216
AIR COILS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glycol heating coils.
- B. Refrigerant coils.

1.02 RELATED REQUIREMENTS

- A. Section 23 0719 - HVAC Piping Insulation.
- B. Section 23 2114 - Hydronic Specialties.
- C. Section 23 2300 - Refrigerant Piping.
- D. Section 23 3100 - HVAC Ducts and Casings: Installation of duct coils.

1.03 REFERENCE STANDARDS

- A. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- C. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Greenheck: www.greenheck.com.
- B. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
- C. Modine: www.modine.com.

2.02 GLYCOL HEATING COILS

- A. Tubes: 5/8 inch OD seamless copper arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
- B. Fins: Aluminum or copper continuous plate type with full fin collars.
- C. Casing: Die formed channel frame of 16 gage, 0.0598 inch galvanized steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.
- D. Headers: Cast iron with tubes expanded into header.
- E. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.
- F. Configuration: Drainable, with threaded plugs in headers for drain and vent.

2.03 REFRIGERANT COILS

- A. Tubes: 5/8 inch OD seamless copper _____ arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
- B. Fins: Aluminum or copper continuous plate type with full fin collars. Solder coat copper fin coils.
- C. Casing: Die formed channel frame of 16 gage, 0.0598 inch galvanized steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.

- D. Headers: Seamless copper or brass tubes with silver brazed joints.
- E. Liquid Distributors: Brass or copper venturi type distributor with seamless copper distributor tubes, 5/16 inch outside diameter; maximum 12 circuits per distributor.
- F. Testing: Air test under water at 300 psi for working pressure of 250 psi; clean, dehydrate, and seal with dry nitrogen charge.
- G. Configuration: Down feed with bottom suction to prevent trapping of oil.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturers written instructions.
- B. Install in ducts and casings in accordance with SMACNA (DCS).
 - 1. Support coil sections independent of piping on steel channel or double angle frames and secure to casings.
- C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- D. Make connections to coils with unions and flanges.
- E. Refrigerant Coils: Provide sight glass in liquid line within 12 inches of coil. Refer to Section 23 2300.

END OF SECTION

SECTION 26 0533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.
- E. Floor boxes.
- F. Underground boxes/enclosures.
- G. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0533.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 2726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.
 - 3. Additional requirements for locating boxes for wiring devices.
- F. Section 27 1000 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- F. NFPA 70 - National Electrical Code.
- G. SCTE 77 - Specifications for Underground Enclosure Integrity.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- J. UL 508A - UL Standard for Safety Industrial Control Panels.
- K. UL 514A - Metallic Outlet Boxes.
- L. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 6000 - Product Requirements, for additional provisions.
 2. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit is used.
 4. Use suitable concrete type boxes where flush-mounted in concrete.
 5. Use suitable masonry type boxes where flush-mounted in masonry walls.
 6. Use raised covers suitable for the type of wall construction and device configuration where required.

7. Use shallow boxes where required by the type of wall construction.
 8. Do not use "through-wall" boxes designed for access from both sides of wall.
 9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 13. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 27 1000.
 - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
 14. Wall Plates: Comply with Section 26 2726.
 15. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
 - c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
1. Manufacturers:
 - a. Hubbell Incorporated: www.hubbell.com/#sle.
- E. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
1. Manufacturers:
 - a. Appleton, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - b. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - c. Hubbell Incorporated; Killark Products: www.hubbell-killark.com/#sle.
- F. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 2726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 2. Manufacturer: Same as manufacturer of floor box service fittings.

G. Underground Boxes/Enclosures:

1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Provide logo on cover to indicate type of service.
5. Applications:
 - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.
 - b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 15 load rating.
 - c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
 - a. Manufacturers:
 - 1) Hubbell Incorporated; Quazite Products: www.hubbellpowersystems.com/#sle.
 - 2) MacLean Highline: www.macleanhighline.com/#sle.
 - 3) Oldcastle Precast, Inc: www.oldcastleprecast.com/#sle.
 - b. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.
 - c. Product(s):
 - 1) MacLean Highline PHA Series: Straight wall, all-polymer concrete splice box/pull box; available Tier 8, Tier 15, and Tier 22 load ratings.
 - 2) MacLean Highline CHA Series: Fiberglass/polymer concrete splice box/pull box; available Tier 8 and Tier 15 load ratings.
 - 3) MacLean Highline CVA Series: Fiberglass/polymer concrete splice vault; available Tier 8, Tier 15, and Tier 22 load ratings.

2.02 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.
1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.

2. Unless dimensioned, box locations indicated are approximate.
 3. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726.
 - b. Communications Systems Outlets: Comply with Section 27 1000.
 4. Locate boxes so that wall plates do not span different building finishes.
 5. Locate boxes so that wall plates do not cross masonry joints.
 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.
 11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Underground Boxes/Enclosures:
1. Install enclosure on gravel base, minimum 6 inches deep.
 2. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

- N. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- P. Close unused box openings.
- Q. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- R. Provide grounding and bonding in accordance with Section 26 0526.
- S. Identify boxes in accordance with Section 26 0553.

3.03 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

**SECTION 26 0505
SELECTIVE DEMOLITION FOR ELECTRICAL**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

1.02 RELATED REQUIREMENTS

- A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

1.03 ADMINISTRATIVE REQUIREMENTS:

- A. Survey and document all equipment and components scheduled for removal. Provide listing to Owner for review. Contractor is to deliver all items identified by Owner to be retained over to Owner. All other equipment and associated components shall become the Contractor's property. Contractor is responsible for prompt removal of equipment from project site in accordance with applicable federal, state, and local regulations.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Demolition drawings are based on casual field observation and existing record documents.
- C. Report discrepancies to Architect before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
 - 3. Make notifications at least 24 hours in advance.
 - 4. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 - 1. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.

- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

SECTION 26 0510
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical Requirements

1.02 RELATED REQUIREMENTS

- A. Refer to Section 01 0000 - General Requirements.

1.03 REFERENCE STANDARDS

- A. The following standards shall govern and shall constitute minimum requirements as approved. If the requirements of this specification exceed those of the standards mentioned, this specification shall govern.
 - 1. Local Building Codes.
 - 2. Underwriters Laboratories, Inc., (UL) approved or listed: All materials shall be UL approved or third party certified.
 - 3. Local Electric Utility: Standards in effect on bidding date.
 - 4. Local Telephone Utility: Standards in effect on bidding date for service entrance.
 - 5. National Electrical Manufacturer's Association, NEMA: Equipment enclosures, mountings and connections.
 - 6. America National Standards Institute, ANSI: Where mentioned herein.
 - 7. American Institute of Electronic and Electrical Engineers, IEEE: Power equipment.
 - 8. National Electrical Safety Code, NESC: Outdoor and overhead work for temporary service.
 - 9. Occupational Safety and Health Act, OSHA: Requirements for safety and health of employees.
 - 10. National Fire Prevention Association, NFPA:
 - a. 70, National Electric Code, NEC.
 - b. 101, Life Safety Code.
 - 11. Building Code of New York State.
 - 12. Fire Code of New York State.
 - 13. Energy Conservation Construction Code of New York State.
 - 14. New York State Department of Labor Rules and Regulations.
 - 15. New York State Education Department "Manual of Planning Standards".
- B. References to codes, specifications, and standards called for in the specification sections and on the drawings mean, the latest edition, amendment and revision adopted by the authority have jurisdiction in effect on the date of these contract documents.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Provide all labor, items, articles, materials, operations, methods, or equipment listed, mentioned, indicated, or scheduled on the drawings and specified herein, and required to complete the electrical work.
- B. Electrical trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings.
- C. Cost of fees shall be included in the bid as follows:
 - 1. Construction permits.
 - 2. Inspections and tests as described in this section.
- D. Contract drawings and specifications are complementary and must be so construed to determine the full scope of work.
- E. Drawings:
 - 1. Contract Drawings are, in part, diagrammatic and are intended to convey the scope of the work and indicate the general arrangement of the equipment. Follow these Drawings in laying out the work. Consult all drawings to become familiar with all conditions affecting the Work and to verify spaces in which the work will be installed.

2. Reasonable changes required by job conditions (including offsetting of conduits around beams, etc.) shall be made, after obtaining the Engineer's approval, at no additional cost to the Owner .

F. Definitions:

1. The term "provide" shall have the same meaning as "furnish and install". All materials so implied either on the drawings or in these specifications shall be furnished and installed unless specifically noted otherwise.
2. The term "circuitry" shall have the same meaning as "conductors, pathway, and all associated components required for a complete circuit".

1.05 SUBMITTALS

- A. Reference Section 01 3000 - Administrative Requirements for submittal process.

1.06 QUALITY ASSURANCE

A. Licensing

1. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
2. Electrical Contract Work shall be performed by, or under, the direct supervision of a Licensed Electrician.

- B. Underwriters' Certificate: Prior to submittal of Request for Final Payment, an electrical inspection certificate shall be obtained and submitted for approval. List of approved 3rd party inspecting underwriters is listed below:

1. Commonwealth of Pennsylvania Inspectors, Mike Kieff (315-408-5709).
2. Electrical Underwriters of NY, LLC (845-569-1759).
3. Inspections on Time (845-233-6711)
4. Other Underwriters are not restricted, however credentials shall be provided for Engineer approval prior to Inspection.

1.07 FIELD CONDITIONS

- A. Prior to commencement of work, the Contractor(s) effecting such system shall survey all building electrical systems and components, including fire alarm, intrusion, communications, clock and computer; make written notice to the Owner regarding existing damages, missing items and incomplete systems. Prior to the conclusion of this project, the Contractor shall verify with the Project Representative that all building systems have been returned to their original conditions.
- B. Any discrepancies shall be called to the attention of the Engineer before bids are taken. Bids shall be based on code and functional adequacy. Failure of the Contractor in this respect shall not relieve him of responsibility for a fully adequate installation at no increase in cost.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide new equipment and material unless otherwise called for.
- B. All equipment and/or materials shall be new and shall carry the label of Underwriter's Laboratories Inc., whenever UL requirements are applicable.
- C. Materials of same general type, such as wiring devices and luminaries, shall be of the same make throughout the building so that appearance and operation are uniform.

PART 3 EXECUTION

3.01 CLEANING AND REPAIR

A. Cutting and Patching

1. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch any cut or abandoned holes left by removals of equipment, fixtures, etc. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

- B. Contractor shall at all times keep the project free from accumulation of waste material or rubbish caused by his operation.
- C. When directed, just prior to final acceptance, clean all equipment under contract including, but not limited to the following:
 - 1. Lighting fixtures, panelboards, control centers, clocks, receptacles, and switch plates.
 - 2. All equipment to be painted, removing all rust, etc., and leave ready for painting.
 - 3. Building, by removing all debris, leftover conduits, wire insulation, cartons, etc., left because of this work.

END OF SECTION

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 2 PRODUCTS

1.01 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 - 1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 2. Tinned Copper Conductors: Comply with ASTM B33.
- H. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - 3. Color Code:
 - a. Equipment Ground, All Systems: Green.

1.02 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

END OF SECTION

**SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.

1.02 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
 - 1. Includes oxide inhibiting compound.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- C. NFPA 70 - National Electrical Code.
- D. UL 467 - Grounding and Bonding Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Field quality control test reports.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 - 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 - 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 - 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 - 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
- F. Communications Systems Grounding and Bonding:
 - 1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 - 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 - 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Burndy LLC: www.burndy.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Cadweld, a brand of Erico International Corporation: www.erico.com/#sle.

- c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC:
www.thermoweld.com/#sle.
- D. Ground Bars:
 - 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 - 2. Size: As indicated.
 - 3. Holes for Connections: As indicated or as required for connections to be made.
 - 4. Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC:
www.thermoweld.com/#sle.
- E. Oxide Inhibiting Compound: Comply with Section 26 0519.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- C. Section 26 0533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- D. Section 26 5100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- E. Section 26 5600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 - Metal Framing Standards Publication.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
 - 3. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Busway Supports: 1/2 inch diameter.
 - c. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.

- d. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
 - e. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - f. Outlet Boxes: 1/4 inch diameter.
 - g. Luminaires: 1/4 inch diameter.
- F. Anchors and Fasteners:
- 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts.
 - 5. Hollow Stud Walls: Use toggle bolts.
 - 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Wood: Use wood screws.
 - 9. Plastic and lead anchors are not permitted.
 - 10. Powder-actuated fasteners are not permitted.
 - 11. Hammer-driven anchors and fasteners are not permitted.
 - 12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
 - 13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 - 14. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - c. Powers Fasteners, Inc: www.powers.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
 - J. Secure fasteners according to manufacturer's recommended torque settings.
 - K. Remove temporary supports.
 - L. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

**SECTION 26 0533.13
CONDUIT FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. PVC-coated galvanized steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Electrical metallic tubing (EMT).
- F. Rigid polyvinyl chloride (PVC) conduit.
- G. Conduit fittings.
- H. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit.
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- J. NFPA 70 - National Electrical Code.
- K. UL 1 - Flexible Metal Conduit.
- L. UL 6 - Electrical Rigid Metal Conduit-Steel.
- M. UL 360 - Liquid-Tight Flexible Metal Conduit.
- N. UL 514B - Conduit, Tubing, and Cable Fittings.
- O. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- P. UL 797 - Electrical Metallic Tubing-Steel.
- Q. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 1. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 2. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
- D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- E. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- F. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
 1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.

- b. Where exposed below 20 feet in warehouse areas.
- J. Exposed, Exterior: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.
- K. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.
- L. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
 - 1. Maximum Length: 6 feet.
- M. Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Motors.

2.02 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 1/2 inch (16 mm) trade size.
 - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 - 3. Control Circuits: 1/2 inch (16 mm) trade size.
 - 4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
 - 5. Underground, Interior: 3/4 inch (21 mm) trade size.
 - 6. Underground, Exterior: 1 inch (27 mm) trade size.
- E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Thomas & Betts Corporation; _____: www.tnb.com/#sle.

2. Robroy Industries; _____: www.robroy.com/#sle.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. PVC-Coated Fittings:
 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
 4. Material: Use steel or malleable iron.
 5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.

2.07 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 2. Nucor Tubular Products: www.nucortubular/#sle.
 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.
 - 5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. Cantex Inc: www.cantexinc.com/#sle.
 - 2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.
 - 3. JM Eagle: www.jmeagle.com/#sle.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.09 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.
- G. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
 - 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
- H. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
 - 1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
- I. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- F. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal all conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.
 - 11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 - 12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 - 13. Group parallel conduits in the same area together on a common rack.
- G. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 - 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.

5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
 9. Use of spring steel conduit clips for support of conduits is not permitted.
 10. Use of wire for support of conduits is not permitted.
- H. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
 8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- J. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
 2. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length for service entrance where not concrete-encased.
- K. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.
- L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.

- M. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - 1. Where conduits pass from outdoors into conditioned interior spaces.
 - 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- N. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- O. Provide grounding and bonding in accordance with Section 26 0526.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

**SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.02 RELATED REQUIREMENTS

- A. Section 09 9113 - Exterior Painting.
- B. Section 09 9123 - Interior Painting.
- C. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 26 2726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- E. Section 27 1000 - Structured Cabling: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.
- B. UL 969 - Marking and Labeling Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) Identify ampere rating.

- 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
- b. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - c. Busway:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Provide identification at maximum intervals of 40 feet.
 - 5) Use identification nameplate to identify load(s) served for each plug-in unit. Include location when not within sight of equipment.
 - d. Time Switches:
 - 1) Identify load(s) served and associated circuits controlled. Include location.
2. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 3. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
 4. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
 5. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
 6. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
 - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 9123 and 09 9113.
 7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
- B. Identification for Conductors and Cables:**
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
 2. Identification for Communications Conductors and Cables: Comply with Section 27 1000.
 3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:

- a. At each source and load connection.
- b. Within boxes when more than one circuit is present.
- c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
- 5. Use underground warning tape to identify direct buried cables.
- C. Identification for Raceways:
 - 1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
 - 2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
 - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Color Code:
 - (a) Emergency Power System: Red.
 - (b) Fire Alarm System: Red.
 - 2) Field-Painting: Comply with Section 09 9123 and 09 9113.
 - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.
 - 3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
 - 4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
 - 5. Use underground warning tape to identify underground raceways.
 - 6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.
- D. Identification for Boxes:
 - 1. Use voltage markers to identify highest voltage present.
 - 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 09 9123 and 09 9113 per the same color code used for raceways.
 - 3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, use only identification labels.
- E. Identification for Devices:
 - 1. Identification for Communications Devices: Comply with Section 27 1000.
 - 2. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
 - 3. Use identification label to identify fire alarm system devices.
 - 4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
 - 5. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
 - 6. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.
- F. Identification for Luminaires:
 - 1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 - 1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products: www.seton.com/#sle.

2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend:
 - a. System designation where applicable:
 - 1) Emergency Power System: Identify with text "EMERGENCY".
 - 2) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
- D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/4 inch.
 5. Color: Black text on white background unless otherwise indicated.
 - a. Exceptions:
 - 1) Provide white text on red background for general information or operational instructions for emergency systems.
 - 2) Provide white text on red background for general information or operational instructions for fire alarm systems.
- E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.

3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/2 inch.
 5. Color: Black text on yellow background unless otherwise indicated.
- F. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Power source and circuit number or other designation indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Black text on clear background.
- G. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Load controlled or other designation indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Black text on clear background.
- H. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Designation indicated and device zone or address.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

- A. Manufacturers:
1. Brady Corporation: www.bradyid.com/#sle.
 2. HellermannTyton: www.hellermanntyton.com/#sle.
 3. Panduit Corp: www.panduit.com/#sle.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
1. Do not use handwritten text.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

- A. Manufacturers:
1. Brady Corporation: www.bradyid.com/#sle.
 2. Brimar Industries, Inc: www.brimar.com/#sle.
 3. Seton Identification Products: www.seton.com/#sle.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- D. Minimum Size:
1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.

- E. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
 - b. Other Systems: Type of service.
- F. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
- B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.06 FLOOR MARKING TAPE

- A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.

2.07 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com/#sle.
 - 2. Clarion Safety Systems, LLC: www.clarionsafety.com/#sle.
 - 3. Insite Solutions, LLC: www.stop-painting.com/#sle.
 - 4. Seton Identification Products: www.seton.com/#sle.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Boxes: Outside face of cover.
 - 9. Conductors and Cables: Legible from the point of access.
 - 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

**SECTION 26 0583
WIRING CONNECTIONS**

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 26 0533.13 - Conduit for Electrical Systems.
- B. Section 26 0533.16 - Boxes for Electrical Systems.
- C. Section 26 2726 - Wiring Devices.
- D. Section 26 2816.16 - Enclosed Switches.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Disconnect Switches: As specified in Section 26 2816.16 and in individual equipment sections.
- B. Wiring Devices: As specified in Section 26 2726.
- C. Boxes: As specified in Section 26 0533.16.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

- F. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

**SECTION 26 0923
LIGHTING CONTROL DEVICES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Occupancy sensors.

1.02 RELATED REQUIREMENTS

- A. Section 26 0529 - Hangers and Supports for Electrical Systems
- B. Section 26 0533.16 - Boxes for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 2726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.
 - 1. Includes finish requirements for wall controls specified in this section.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
- D. NFPA 70 - National Electrical Code.
- E. UL 1472 - Solid-State Dimming Controls.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
 - 3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
 - 4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install lighting control devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 - 1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.
- C. Shop Drawings:
 - 1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
 - 2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.
- D. Field Quality Control Reports.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all occupancy sensors.
- C. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.
- C. Products for Switching of Electronic Ballasts/Drivers: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.02 OCCUPANCY SENSORS

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 - 3. Sensor Switch Inc: www.sensorswitch.com/#sle.
 - 4. WattStopper: www.wattstopper.com/#sle.
 - 5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. All Occupancy Sensors:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
 - b. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.
 - 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 - 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
 - 5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
 - 6. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
 - 7. Sensitivity: Field adjustable.
 - 8. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.

9. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings.
 10. Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.
- C. Wall Switch Occupancy Sensors:
1. All Wall Switch Occupancy Sensors:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
 - c. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
 - d. Finish: Match finishes specified for wiring devices in Section 26 2726, unless otherwise indicated.
 2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
 - a. Products:
 - 1) Lutron Maestro Series; www.lutron.com/#sle.
 3. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
 - a. Products:
 - 1) Lutron Maestro Series; www.lutron.com/#sle.
 - 2) Substitutions: See Section 01 6000 - Product Requirements.
- D. Wall Dimmer Occupancy Sensors:
1. General Requirements:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.
 - b. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
 - c. Provide field adjustable dimming preset for occupied state.
 - d. Provide fade-to-off operation to notify occupant of impending load turn-off.
 - e. Finish: Match finishes specified for wiring devices in Section 26 2726, unless otherwise indicated.
 2. Passive Infrared (PIR) Wall Dimmer Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
 - a. Products:
 - 1) Lutron Maestro C.L Sensor Dimmer Series; www.lutron.com/#sle.
 - 2) Lutron Maestro 0-10V Dimmer Sensor Series; www.lutron.com/#sle.
- E. Ceiling Mounted Occupancy Sensors:
1. All Ceiling Mounted Occupancy Sensors:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
 - c. Finish: White unless otherwise indicated.
 2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - 1) Products:
 - (a) Lutron LOS-CIR Series; www.lutron.com/#sle.

- (b) Lutron Radio Powr Savr Wireless Sensors; www.lutron.com/#sle.
- 3. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - 1) Products:
 - (a) Lutron LOS-CDT Series; www.lutron.com/#sle.
- 4. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
- F. Accessories:
 - 1. Provide heavy duty coated steel wire protective guards compatible with specified occupancy sensors where indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of lighting control devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
 - b. In-Wall Time Switches: 48 inches above finished floor.
 - c. In-Wall Interval Timers: 48 inches above finished floor.
 - 2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
 - 3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 2726.
- G. Provide required supports in accordance with Section 26 0529.

- H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- I. Identify lighting control devices in accordance with Section 26 0553.
- J. Occupancy Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
 - 2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 COMMISSIONING

- A. See Section 01 9113 - General Commissioning Requirements for commissioning requirements.

3.08 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
 - 4. Location: At project site.

END OF SECTION

**SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General purpose transformers.
- B. K-factor transformers rated for nonlinear loads.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0533.13 - Conduit for Electrical Systems: Flexible conduit connections.

1.03 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers.
- B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers.
- C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers.
- F. NEMA ST 20 - Dry Type Transformers for General Applications.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- H. NFPA 70 - National Electrical Code.
- I. UL 506 - Standard for Specialty Transformers.
- J. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric: www.se.com/#sle.
- D. Siemens Industry, Inc: www.new.siemens.com/#sle.
- E. Substitutions: See Section 01 6000 - Product Requirements.
- F. Source Limitations: Provide transformers produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 - 1. Altitude: Less than 3,300 feet.
 - 2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.

- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
 - 2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- C. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.
- D. Winding Taps:
 - 1. Less than 3 kVA: None.
 - 2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
 - 3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
 - 4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
- E. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- F. Sound Levels: Standard sound levels complying with NEMA ST 20
- G. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor mounting.
- H. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.

2.04 K-FACTOR TRANSFORMERS RATED FOR NONLINEAR LOADS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 1561, and designed to supply nonlinear loads to the degree designated by the UL defined K-factor; ratings as indicated on the drawings.
- B. K-factor Rating: K-4, or higher.
- C. Insulation System and Allowable Average Winding Temperature Rise: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

- D. Coil Conductors: Continuous aluminum windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.
- E. Winding Taps: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
- F. Neutral Bus: Sized to accommodate twice the rated secondary current.
- G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- H. Sound Levels: Standard sound levels complying with NEMA ST 20
- I. Mounting Provisions:
 - 1. Up to 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 2. Larger than 75 kVA: Suitable for floor mounting.
- J. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Construction: Steel, ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section 26 0533.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Install transformers plumb and level.
- G. Transformer Support:
 - 1. Provide required support and attachment in accordance with Section 26 0529, where not furnished by transformer manufacturer.
 - 2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
 - 3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
 - 4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- H. Provide grounding and bonding in accordance with Section 26 0526.
- I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

3.03 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 2213.16
LOW-VOLTAGE GENERAL PURPOSE ENCAPSULATED TRANSFORMERS - SCHNEIDER ELECTRIC
SQUARE D

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Low-voltage general purpose encapsulated transformers.

1.02 DEFINITIONS

- A. Low-voltage distribution transformers may also be identified as transformer, XFMR, or T.
- B. Low-Voltage General Purpose Transformer:
 - 1. Input and output voltage of 1,000 V or less.
 - 2. Rated for operation at 60 Hz.
 - 3. Air cooled; does not use oil as coolant.
 - 4. 0.05 kVA to 75 kVA for dry-type units.
 - 5. Includes step-up and step-down transformers.
 - 6. Nonventilated transformer core and coil completely embedded in sand/resin preventing external air circulation through coils of transformer while operating at zero gauge pressure; exempt from DOE regulations.

1.03 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. ISO 9001 - Quality Management Systems — Requirements.
- D. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NEMA ST 20 - Dry Type Transformers for General Applications.
- G. NFPA 70 - National Electrical Code.
- H. NFPA 70E - Standard for Electrical Safety in the Workplace.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- J. UL 5085-1 - Low Voltage Transformers – Part 1: General Requirements.
- K. UL 5085-2 - Low Voltage Transformers – Part 2: General Purpose Transformers.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70.
 - 2. Requirements of local authorities having jurisdiction.
 - 3. Applicable local codes.
- B. Manufacturer Qualifications:
 - 1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
 - 2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
 - 3. Service, repair, and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.

4. Certified in accordance with ISO 14001.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.
- B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.
- C. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.
 1. Protect transformers with cardboard or wood material; plastic wrapping is not acceptable.
- D. Inspect products and report concealed damage or violation of delivery, storage, and handling requirements to Engineer.

1.07 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for 12 months from date of commissioning or 18 months from date of shipment, whichever comes first. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric; Square D General Purpose Resin Encapsulated Transformers; www.se.com/#sle.
- B. Source Limitations: Furnish products produced by same manufacturer as other electrical distribution equipment for project and obtained from single supplier.

2.02 LOW-VOLTAGE GENERAL PURPOSE ENCAPSULATED TRANSFORMERS

- A. Basis of Design: Schneider Electric; Square D General Purpose Resin Encapsulated Transformers; www.se.com/#sle.
- B. Transformer Ratings/Configurations: As indicated on drawings.
- C. Comply with NEMA ST 20; listed and labeled as complying with UL 5085-1 and UL 5085-2.
- D. Sound Levels: Standard sound levels complying with NEMA ST 20 unless otherwise indicated.
- E. Cores and Coils:
 1. Coils: Continuous wound construction using wire insulated with 180 degrees C insulation or higher.
 - a. Bare wire is not acceptable.
 2. Winding Material: Aluminum or copper.
 3. Construct cores with low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point to prevent core overheating.
 4. Embed core and coil in sand-resin mixture for encapsulation.
- F. Insulation System: Class 180 degrees C.
- G. Temperature Rise: 115 degrees C.
- H. Taps:
 1. Provide the following available tap capacities as indicated on drawings:
 - a. 240 x 480 V: None.
 - b. 120, 208, 277, and 600 V: None; two 5 percent full capacity primary taps below rated voltage.
 - c. 240 and 480 V: Two 5 percent full capacity primary taps below rated voltage.

- I. Terminals:
 - 1. Provide stripped lead capable of connecting to aluminum or copper conductors or pad capable of accommodating AL9CU lugs.
 - 2. Primary Terminals: Accommodate wire sized for 125 percent of nameplate current.
 - 3. Secondary Terminals: Accommodate wire sized for 125 percent of nameplate current.
- J. Enclosures:
 - 1. Provide third-party certified UL 50E ratings. Self-certification to NEMA 250 is not acceptable.
 - 2. UL 50E Rating, Unless Otherwise Indicated: Type 3R.
 - 3. Construction: Steel.
 - 4. Finish:
 - a. Manufacturer's standard grey; UL component recognized paint process.
 - b. Salt Spray Resistance: 600 hours when tested in accordance with UL requirements.
 - 5. Enclosure Temperature: Not exceeding 90 degrees F above 104 degrees F ambient temperature.
- K. Markings and Labeling:
 - 1. Provide identification and warning labels/nameplates exterior to equipment resistant to weather, UV, and intended installation environment.
 - 2. Nameplate Information:
 - a. Information required by NFPA 70 and NEMA ST 20.
 - b. Identification as distribution transformer, or why it is not.
 - c. Statement of exemption from 10 CFR 431, Subpart K.
 - 3. Provide warning labels/nameplates complying with ANSI Z535.4 at access locations to advise personnel of possible hazards in accordance with listing, NFPA 70, NFPA 70E, and other applicable standards.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions.
- B. Use flexible conduit for connections to transformer enclosure at locations identified by manufacturer.
- C. Arrange equipment to provide minimum clearance in accordance with transformer nameplate and manufacturer's instructions.
- D. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.
 - 1. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.
- C. Perform high-potential test to verify connections are cleared from ground.
- D. Measure primary and secondary voltages and make appropriate tap adjustments.
- E. Verify that energized transformer does not emit excessive noise with front cover installed. Contact manufacturer if noise is other than standard 120 Hz constant hum.

3.03 PROTECTION

- A. Protect installed transformers from subsequent construction operations.

3.04 MAINTENANCE

- A. See Section 26 0160.13 for additional information.

- B. Provide to Owner, as alternate to base bid, separate contract for switchgear service plan for two years from date of Substantial Completion including, but not limited to, dedicated customer success management team, priority remote and on-site (within 100 miles of service location) expert support, discounted service rates, continuous monitoring and alarming, online training.

END OF SECTION

**SECTION 26 2726
WIRING DEVICES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.

1.02 RELATED REQUIREMENTS

- A. Section 26 0533.16 - Boxes for Electrical Systems.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices.
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- G. NFPA 70 - National Electrical Code.
- H. UL 20 - General-Use Snap Switches.
- I. UL 498 - Attachment Plugs and Receptacles.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.
- K. UL 943 - Ground-Fault Circuit-Interrupters.
- L. UL 1472 - Solid-State Dimming Controls.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
 - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Project Record Documents: Record actual installed locations of wiring devices.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
- E. Provide GFCI protection for receptacles installed in kitchens.
- F. Provide GFCI protection for receptacles serving electric drinking fountains.
- G. Unless noted otherwise, do not use combination switch/receptacle devices.
- H. For flush floor service fittings, use tile rings for installations in tile floors.

2.02 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: White with stainless steel wall plate.
- C. Wiring Devices Installed in Finished Spaces: White with stainless steel wall plate.
- D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
- E. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.

2.03 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.04 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.

3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

2.05 RECEPTACLES

- A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 3. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 - a. Products:
 - 1) Hubbell Incorporated: www.hubbell.com/#sle.
 3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

2.06 WALL PLATES

- A. Manufacturers:
1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 5. Substitutions: See Section 01 6000 - Product Requirements.
 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.

2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches above finished floor.
 - b. Wall Dimmers: 48 inches above finished floor.
 - c. Receptacles: 18 inches above finished floor or 6 inches above counter.
 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

- J. Install wall switches with OFF position down.
- K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Identify wiring devices in accordance with Section 26 0553.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

**SECTION 26 2816.16
ENCLOSED SWITCHES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NFPA 70 - National Electrical Code.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- H. UL 98 - Enclosed and Dead-Front Switches.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Project Record Documents: Record actual locations of enclosed switches.
- D. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB/G: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- E. Substitutions: See Section 01 6000 - Product Requirements.
- F. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
- K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- L. Heavy Duty Switches:
 - 1. Comply with NEMA KS 1.
 - 2. Conductor Terminations:

- a. Provide mechanical lugs unless otherwise indicated.
- b. Lug Material: Copper, suitable for terminating copper conductors only.
3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Identify enclosed switches in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

**SECTION 26 3213
ENGINE GENERATORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged engine generator system and associated components and accessories:
 - 1. Engine and engine accessory equipment.
 - 2. Alternator (generator).
 - 3. Generator set control system.
 - 4. Generator set enclosure.
 - 5. The owner will furnish generator to contractor for installation.
 - 6. Contractor to provide equipment pad and install generator on pad.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. ASTM D975 - Standard Specification for Diesel Fuel.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NECA/EGSA 404 - Standard for Installing Generator Sets.
- D. NEMA MG 1 - Motors and Generators.
- E. NFPA 30 - Flammable and Combustible Liquids Code.
- F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
- G. NFPA 70 - National Electrical Code.
- H. NFPA 99 - Health Care Facilities Code.
- I. NFPA 110 - Standard for Emergency and Standby Power Systems.
- J. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids.
- K. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries.
- L. UL 2200 - Stationary Engine Generator Assemblies.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
 - 2. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
 - 1. Include generator set sound level test data.

2. Include characteristic trip curves for overcurrent protective devices upon request.
3. Include alternator thermal damage curve upon request.
- C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- D. Evidence of qualifications for installer.
- E. Evidence of qualifications for maintenance contractor (if different entity from installer).
- F. Manufacturer's factory emissions certification.
- G. Source quality control test reports.
- H. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
 1. Certified prototype tests.
 2. Torsional vibration compatibility certification.
 3. NFPA 110 compliance certification.
 4. Certified rated load test at rated power factor.
- I. Manufacturer's detailed field testing procedures.
- J. Field quality control test reports.
- K. Maintenance contracts.
- L. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.06 QUALITY ASSURANCE

- A. Comply with the following:
 1. NFPA 70 (National Electrical Code).
 2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 2 system.
 3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
 4. NFPA 30 (Flammable and Combustible Liquids Code).
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.
- E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Packaged Engine Generator Set:
 - 1. Caterpillar Inc: www.cat.com/#sle.
 - 2. Cummins Power Generation Inc: www.cumminspower.com/#sle.
 - 3. Generac Power Systems: www.generac.com/industrial/#sle.
 - 4. Kohler Co: www.kohlerpower.com/#sle.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

- A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. System Description:
 - 1. Application: Emergency/standby.
 - 2. Configuration: Single packaged engine generator set operated independently (not in parallel).
- D. Packaged Engine Generator Set:
 - 1. Type: Gaseous (spark ignition).
 - 2. Power Rating: As indicated on drawings, standby.
 - 3. Voltage: As indicated on drawings.
 - 4. Main Line Circuit Breaker:
 - a. Type: Thermal magnetic.
 - b. Trip Rating: Select according to generator set rating.
- E. Generator Set General Requirements:
 - 1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
 - 2. Factory-assembled, with components mounted on suitable base.
 - 3. List and label engine generator assembly as complying with UL 2200.
 - 4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
 - 5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
 - 6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.
- F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
- G. Starting and Load Acceptance Requirements:
 - 1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
 - 2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
 - 3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
 - 4. Maximum Load Step: Supports 100 percent of rated load in one step.
- H. Exhaust Emissions Requirements:
 - 1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.

2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

- A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.
- B. Engine Fuel System - Diesel
 1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
 2. Fuel Storage: Sub-base fuel tank.
 3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
 4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
 - a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
 - b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
 - c. Features:
 - 1) Direct reading fuel level gauge.
 - 2) Normal atmospheric vent.
 - 3) Emergency pressure relief vent.
 - 4) Fuel fill opening with lockable cap.
 - 5) Dedicated electrical conduit stub-up area.
 - 6) Low fuel level switch.
 - 7) Leak detection switch; located within secondary containment interstitial space for detection of primary tank fuel leak.
- C. Engine Starting System:
 1. System Type: Electric, with DC solenoid-activated starting motor(s).
 2. Battery(s):
 - a. Battery Type: Lead-acid.
 - b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
 - c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
 3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
 4. Battery Charger:
 - a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
 - b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within time required by NFPA 110 for Level indicated while carrying normal loads.
 - c. Recognized as complying with UL 1236.
 - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
 - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
 - f. Provide alarm output contacts as necessary for alarm indications.
 5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.
- D. Engine Speed Control System (Governor):

1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
 2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.
- E. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
- F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
 2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
- G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
 2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

2.04 ALTERNATOR (GENERATOR)

- A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.
- B. Exciter:
1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
 2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
 3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
- C. Temperature Rise: Comply with UL 2200.
- D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
- E. Enclosure: NEMA MG 1, drip-proof.
- F. Total Harmonic Distortion: Not greater than five percent.
- G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.05 GENERATOR SET CONTROL SYSTEM

- A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
- B. Control Panel:
1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
 2. Generator Set Control Functions:
 - a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
 - b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
 - c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
 - d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
 - e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
 - f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
 - g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
 3. Generator Set Status Indications:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.

- b. Current (Amps): For each phase.
 - c. Frequency (Hz).
 - d. Real power (W/kW).
 - e. Reactive power (VAR/kVAR).
 - f. Apparent power (VA/kVA).
 - g. Power factor.
 - h. Duty Level: Actual load as percentage of rated power.
 - i. Engine speed (RPM).
 - j. Battery voltage (Volts DC).
 - k. Engine oil pressure.
 - l. Engine coolant temperature.
 - m. Engine run time.
 - n. Generator powering load (position signal from transfer switch).
4. Generator Set Protection and Warning/Shutdown Indications:
- a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).
 - 8) Low coolant level (warning/shutdown).
 - 9) Generator control not in automatic mode (warning).
 - 10) High battery voltage (warning).
 - 11) Low cranking voltage (warning).
 - 12) Low battery voltage (warning).
 - 13) Battery charger failure (warning).
 - b. In addition to NFPA 110 requirements, provide the following protections/indications:
 - 1) High AC voltage (shutdown).
 - 2) Low AC voltage (shutdown).
 - 3) High frequency (shutdown).
 - 4) Low frequency (shutdown).
 - 5) Overcurrent (shutdown).
 - 6) Fuel tank leak (warning), where applicable.
 - c. Provide contacts for local and remote common alarm.
 - d. Provide lamp test function that illuminates all indicator lamps.
5. Other Control Panel Features:
- a. Event log.
 - b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
 - c. Remote monitoring capability via PC.
- C. Remote Annunciator:
- 1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
 - 2. Generator Set Status Indications:
 - a. Generator powering load (via position signal from transfer switch).
 - b. Communication functional.
 - 3. Generator Set Warning/Shutdown Indications:
 - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following indications:
 - 1) Overcrank (shutdown).

- 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).
 - 8) Low coolant level (warning/shutdown).
 - 9) Generator control not in automatic mode (warning).
 - 10) High battery voltage (warning).
 - 11) Low cranking voltage (warning).
 - 12) Low battery voltage (warning).
 - 13) Battery charger failure (warning).
- b. Provide audible alarm with silence function.
 - c. Provide lamp test function that illuminates all indicator lamps.
- D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.06 GENERATOR SET ENCLOSURE

- A. Enclosure Type: Sound attenuating, weather protective.
- B. Enclosure Material: Steel or aluminum.
- C. Hardware Material: Stainless steel.
- D. Color: Manufacturer's standard.
- E. Access Doors: Lockable, with all locks keyed alike.
- F. Openings: Designed to prevent bird/rodent entry.
- G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
- H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
- I. Enclosure Space Heater: Provide thermostatically controlled enclosure space heater to prevent condensation and improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

2.07 SOURCE QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.
- C. Generator Set production testing to include, at a minimum:
 1. Operation at rated load and rated power factor.
 2. Single step load pick-up.
 3. Transient and steady state voltage and frequency performance.
 4. Operation of safety shutdowns.
- D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive equipment.

- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
- D. Arrange equipment to provide minimum clearances and required maintenance access.
- E. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 03 3000.
- F. Provide required support and attachment in accordance with Section 26 0529.
- G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
- H. Provide natural gas piping in accordance with Section 23 1123.
- I. Provide engine exhaust piping factory installed.
 - 1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
 - 2. Do not exceed manufacturer's maximum back pressure requirements.
- J. Provide grounding and bonding in accordance with Section 26 0526.
- K. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- C. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.
- D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
- F. Preliminary inspection and testing to include, at a minimum:
 - 1. Inspect each system component for damage and defects.
 - 2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
 - 3. Check for proper oil and coolant levels.
- G. Prepare and start system in accordance with manufacturer's instructions.
- H. Perform acceptance test in accordance with NFPA 110.
- I. Inspection and testing to include, at a minimum:
 - 1. Verify compliance with starting and load acceptance requirements.
 - 2. Verify voltage and frequency; make required adjustments as necessary.
 - 3. Verify phase sequence.
 - 4. Verify control system operation, including safety shutdowns.
 - 5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
 - 6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).
- J. Provide field emissions testing where necessary for certification.
- K. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.

- L. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- M. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
- E. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters.

3.06 PROTECTION

- A. Protect installed engine generator system from subsequent construction operations.

3.07 MAINTENANCE

- A. Provide to Owner at no extra cost, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.
- B. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
- C. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 4 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- D. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION

**SECTION 26 5100
INTERIOR LIGHTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 0529 - Hangers and Supports for Electrical Systems.
- B. Section 26 0533.16 - Boxes for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
- B. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems.
- E. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems.
- F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.
- G. NFPA 70 - National Electrical Code.
- H. UL 844 - Luminaires for Use in Hazardous (Classified) Locations.
- I. UL 1598 - Luminaires.
- J. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 3. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
- D. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

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

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Alloy LED; www.alloyled.com/#sle.
 - 3. California Accent Lighting, Inc; www.calilighting.com/#sle.
 - 4. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
- I. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.
- J. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- K. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.

- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
- C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure surface-mounted and recessed luminaires to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
 - 7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- H. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
 - 4. Install canopies tight to mounting surface.

- 5. Unless otherwise indicated, support pendants from swivel hangers.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K. Install accessories furnished with each luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.
- M. Identify luminaires connected to emergency power system in accordance with Section 26 0553.
- N. Install lamps in each luminaire.
- O. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.06 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

**SECTION 27 0511
REQUIREMENTS FOR COMMUNICATIONS SYSTEMS**

PART 1 GENERAL

1.01 DESCRIPTION

- A. This Section, Requirements for Communications Installations, applies to all sections of Division 27.
- B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, and other items and arrangements for the specified items are shown on drawings.

1.02 MINIMUM REQUIREMENTS

- A. References to industry and trade association standards and codes are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.03 RELATED REQUIREMENTS

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

1.04 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
 - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 - 2. The Owner reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.05 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and with the total assembly for the intended service.
 - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
 - 1. The Owner shall have the option of witnessing factory tests. The contractor shall notify the Owner a minimum of 15 working days prior to the manufacturers making the factory tests.
 - 2. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of the tests.
 - 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Owner.

1.06 EQUIPMENT REQUIREMENTS

- A. Where variations from the contract requirements are requested in accordance with the GENERAL CONDITIONS, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.07 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
 - 1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
 - 2. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 - 3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
 - 4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.08 WORK PERFORMANCE

- A. Job site safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by GENERAL CONDITIONS.
- D. Coordinate location of equipment and pathways with other trades to minimize interferences. See the GENERAL CONDITIONS.

1.09 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Inaccessible Equipment:
 - 1. Where the Owner determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
 - 2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.10 EQUIPMENT IDENTIFICATION

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

1.11 SUBMITTALS

- A. Submit in accordance with GENERAL CONDITIONS.
- B. The Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
1. Mark the submittals, "SUBMITTED UNDER SECTION _____".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. Submit each section separately.
- E. The submittals shall include the following:
1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
 3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- F. Manuals: Submit in accordance with GENERAL CONDITIONS.
1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
 2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
 3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
 4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation and maintenance instructions.
 - e. Safety precautions.
 - f. Diagrams and illustrations.
 - g. Testing methods.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.

1.12 TRAINING

- A. Training shall be provided in accordance with the GENERAL CONDITIONS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.

- C. A training schedule shall be developed and submitted by the contractor and approved by the Engineer at least 30 days prior to the planned training.

END OF SECTION

SECTION 27 0526
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies general grounding and bonding requirements of telecommunication installations for equipment operations.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.02 RELATED WORK

- A. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 27.
- B. Section 27 10 00, STRUCTURED CABLING: Low Voltage power and lighting wiring.

1.03 RELATED REQUIREMENTS

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

1.04 SUBMITTALS

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Engineer:
 - 1. Certification that the materials and installation is in accordance with the drawings and specifications.
 - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.05 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. American Society for Testing and Materials (ASTM):
 - 1. B1-2001 Standard Specification for Hard-Drawn Copper Wire
 - 2. B8-2004 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. 81-1983 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
 - 1. 70-2005 National Electrical Code (NEC)
 - 2. Telecommunications Industry Association, (TIA)
- D. J-STO-607-A-202 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 1. E. Underwriters Laboratories, Inc. (UL):

2. 44-2005 Thermoset-Insulated Wires and Cables
3. 83-2003 Thermoplastic-Insulated Wires and Cables
4. 467-2004 Grounding and Bonding Equipment
5. 486A-486B-2003 Wire Connectors

PART 1 - PRODUCTS

2.01 GROUNDING AND BONDING CONDUCTORS

- A. Telecom System Grounding Riser Conductor between the MTGB and TGB's: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 85mm² (3/0 AWG) ASTM B8 bare stranded copper grounding conductor unless indicated otherwise on drawings.
- B. Equipment grounding conductors shall be UL 83 Insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.
- C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.

2.02 GROUND RODS

- A. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance.

2.03 SPLICES AND TERMINATION COMPONENTS

- A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.04 TELECOMMUNICATION SYSTEM GROUND BUSBARS

- A. Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 6 mm (1/4 inch) for wall and backboard mounting using standard insulators sized as follows:
 1. Main Telecom Grounding Bar (MTGB): 600 mm x 100 mm (24 inches x 4 inch). Locate in Main Electrical Service Rooms as shown on drawings.
 2. Telecom Grounding Bar (TGB) 300 mm x 100 mm (12 inches x 4 inch). Locate in Telecom Rooms as shown on drawings

2.05 GROUND CONNECTIONS

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
 3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.
- C. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

2.06 EQUIPMENT RACK AND CABINET GROUND BARS

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x 3/4 inch).

2.07 GROUND TERMINAL BLOCKS

- A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.08 SPLICE CASE GROUND ACCESSORIES

- A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

PART 1 - EXECUTION

3.01 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
 - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
 - 3. Isolation transformers and isolated power systems shall not be system grounded.
- C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.02 INACCESSIBLE GROUNDING CONNECTIONS

- A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.03 SECONDARY EQUIPMENT AND CIRCUITS

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
 - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
 - 2. Provide a supplemental ground electrode and bond to the grounding electrode system.
- C. Conduit Systems:
 - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 - 2. Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
 - 3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.
- D. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- E. Boxes, Cabinets, Enclosures, and Panelboards:
 - 1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
 - 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 - 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- F. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.
- G. Raised Floors: Provide bonding of all raised floor components. //See details on the drawings.

3.04 CORROSION INHIBITORS

- A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.05 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- B. In operating rooms and at intensive care and coronary care type beds, bond the gases and suction piping, at the outlets, directly to the room or patient ground bus.

3.06 TELECOMMUNICATIONS SYSTEM

- A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.
- B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.
- D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milli ohms or less.
- E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Engineer prior to backfilling any ground connections.
- F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.
- G. Bonding Jumpers:
 - 1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 16 mm² (6 AWG) insulated copper wire.
 - 2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
 - 3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.
- H. Bonding Jumper Fasteners:
 - 1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
 - 2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
 - 3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
 - 4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

3.07 COMMUNICATION ROOM GROUNDING

- A. Telecommunications Ground Busbars:
 - 1. Provide communications room telecommunications ground busbar hardware at 950 mm (18 inches) at locations indicated on the Drawings.

2. Connect the telecommunications room ground busbars to other room grounding busbars as indicated on the Grounding Riser diagram.
- B. Telephone-Type Cable Rack Systems: aluminum pan installed on telephone-type cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:
1. Install a 16 mm² (6 AWG) bonding between the telecommunications ground busbar and the nearest access to the aluminum pan installed on the cable rack.
 2. Use 16 mm² (6 AWG) bonding jumpers across aluminum pan junctions.
- C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:
1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using solid copper splice plates supplied by the ground bar manufacturer.
 2. Bond together nonadjacent ground bars on equipment racks and cabinets with 16 mm² (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
 3. Provide a 16 mm² (6 AWG) bonding jumper between the rack and/or cabinet ground busbar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.
- D. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 mm² (6 AWG) bonding jumper.
- E. Other Communication Room Ground Systems: Ground all metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground busbar, whichever is closer, using insulated 16 mm² (6 AWG) ground wire bonding jumpers.

3.08 COMMUNICATIONS CABLE GROUNDING

- A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
1. At terminal points, install a cable shield bonding connector provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.
 2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

3.09 COMMUNICATIONS CABLE TRAY SYSTEMS:

- A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout this cable tray systems as follows:
1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Subcontractor shall verify this loss by testing across one splice plate connection in the presence of the Contractor.
 2. Install a 16 mm² (6 AWG) bonding jumper across each cable tray splice or junction where splice plates cannot be used.
 3. When cable tray terminations to cable rack, install 16 mm² (6 AWG) bonding jumper between cable tray and cable rack pan.

3.10 COMMUNICATIONS RACEWAY GROUNDING

- A. Conduit: Use insulated 16 mm² (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.

- B. Wireway: use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.
- C. Cable Tray Systems: Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 16 meters (50 feet).

3.11 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.

3.12 GROUND ROD INSTALLATION

- A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.
- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.
- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION

**SECTION 27 0528
INTERIOR PATHWAYS**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for all communications cabling unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.
- C. Provide all labor, materials, tools and equipment required for the complete installation of work called for in the contract documents.

1.02 RELATED WORK

- A. Mounting board for communication closets.
- B. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- C. Fabrications for the deflection of water away from the building envelope at penetrations: Section 07 62 00, SHEET METAL FLASHING AND TRIM.
- D. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building
- E. Identification and painting of conduit and other devices.
- F. General electrical requirements and items that is common to more than one section of Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- G. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.03 RELATED REQUIREMENTS

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

1.04 SUBMITTALS

- A. In accordance with GENERAL CONDITIONS, furnish the following:
- B. Shop Drawings:
 - 1. Size and location of panels and pull boxes
 - 2. Layout of required conduit penetrations through structural elements.
 - 3. The specific item proposed and its area of application shall be identified on the catalog cuts.
- C. Certification: Prior to final inspection, deliver to the Engineer A certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.05 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. National Fire Protection Association (NFPA):
 - 1. 70-05 National Electrical Code (NEC)
- B. Underwriters Laboratories, Inc. (UL):
 - 1. 1-03 Flexible Metal Conduit
 - 2. 5-01 Surface Metal Raceway and Fittings
 - 3. 6-03 Rigid Metal Conduit
 - 4. 50-03 Enclosures for Electrical Equipment
 - 5. 360-03 Liquid-Tight Flexible Steel Conduit

6. 467-01 Grounding and Bonding Equipment
 7. 514A-01 Metallic Outlet Boxes
 8. 514B-02 Fittings for Cable and Conduit
 9. 514C-05 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
 10. 651-02 Schedule 40 and 80 Rigid PVC Conduit
 11. 651A-03 Type EB and A Rigid PVC Conduit and HDPE Conduit
 12. 797-03 Electrical Metallic Tubing
 13. 1242-00 Intermediate Metal Conduit
- C. National Electrical Manufacturers Association (NEMA):
1. TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
 2. FB1-03 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 1 - PRODUCTS

2.01 CONDUIT:

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (1/2 inch) unless otherwise shown.
1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
 2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
 3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
 4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
 5. Flexible galvanized steel conduit: Shall Conform to UL 1.
 6. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
 7. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).
 8. Surface metal raceway: Shall Conform to UL 5.

2.02 CONDUIT FITTINGS:

- A. Rigid steel and IMC conduit fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
 2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 3. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 4. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 5. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
 6. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
- B. Rigid aluminum conduit fittings:
1. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
 2. Locknuts and bushings: As specified for rigid steel and IMC conduit.
 3. Set screw fittings: Not permitted for use with aluminum conduit.
- C. Electrical metallic tubing fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
 2. Only steel or malleable iron materials are acceptable.

3. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
 4. Indent type connectors or couplings are prohibited.
 5. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- D. Flexible steel conduit fittings:
1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
 2. Clamp type, with insulated throat.
- E. Liquid-tight flexible metal conduit fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
 2. Only steel or malleable iron materials are acceptable.
 3. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- F. Direct burial plastic conduit fittings:
1. Fittings shall meet the requirements of UL 514C and NEMA TC3.
 2. As recommended by the conduit manufacturer.
- G. Surface metal raceway fittings: As recommended by the raceway manufacturer.
1. Expansion and deflection couplings:
 - a. Conform to UL 467 and UL 514B.
 - b. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

2.03 CONDUIT SUPPORTS:

- A. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
- B. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
- C. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
- D. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

2.04 OUTLET, JUNCTION, AND PULL BOXES:

- A. UL-50 and UL-514A.
- B. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
- C. Sheet metal boxes: Galvanized steel, except where otherwise shown.
- D. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.

2.05 WIREWAYS:

- A. Equip with hinged covers, except where removable covers are shown.

2.06 INNERDUCT:

- A. Standard HDPE
 1. Textile Innerduct : Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape as manufactured by MaxCell:

- a. MaxCell Group/TVC Communications
 - b. 600 Plum Creek Dr.
 - c. Wadsworth, OH. 44281
 - d. 1-888-387-3828
2. Textile innerduct fittings
 - a. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.: a 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
 - b. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.
 - c. Pull Tape: measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.

2.07 SURFACE METALLIC RACEWAY

- A. Refer to drawings for additional surface raceway sizes, cable fill tables, and cable radius requirements.
- B. TYPE SR-2 (V2400 series)
 1. .875" H x 1.875"W
 2. Metallic two piece raceway with single compartment.
 3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
 4. Refer to Drawings for additional information and requirements.
 5. Provide the following fittings:
 - a. Entrance end fitting - nominal maximum dimensions of 2.62"W x 2.25"H x 3" L. and 1" conduit knockout.
 - b. Back entrance end fitting - same as entrance end fitting with internal radius.
 - c. Tee fittings to connect to SR-3 (3000 Series) and SR-4 (4000 Series) raceway where T section to SR-2 (2400 Series) has maximum width equal to SR-2 raceway
 - d. Bridge fitting with radius for spanning existing raceways in varying widths from ½" to 2.
 - e. Flat Internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A. Internal or external radius control must be provided. Derate fill capacities when internal radius control is provided, as recommended by the manufacturer.
 - f. Surface 2" x 4" or 4" x 4" boxes, with 2.25" depth as called for.
 6. Design Make: Wiremold V2400 series raceway, V2475D series bridge fittings, V2410 series entrance end fittings, V2415 T fittings.
 7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.
- C. TYPE SR-3 (V3000 Series)
 1. 1.5" H x 2.75"W
 2. Metallic two piece raceway with single compartment.
 3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
 4. Refer to Drawings for additional information and requirements.
 5. Provide the following fittings:
 - a. Entrance end fitting - nominal maximum dimensions of 2.75"W x 2"H x 2.125" L. and 1" conduit knockout.
 - b. Back entrance end fitting - same as entrance end fitting with internal radius.
 - c. Tee fittings to connect to SR-2 (2400 Series) raceway where T section to SR-2 has maximum width equal to SR-2 raceway
 - d. Flat Internal and external elbows UL verified for a 2" [51mm] bend radius and exceeding the recommendations of EIA/TIA 569A using internal or external radius components. Internal or external radius control must be provided. Derate fill capacities when internal radius control is provided, as recommended by the manufacturer.
 6. Design Make: Wiremold V3000 series raceway, with V3011, V3010 and V3018 fittings.
 7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.

- D. TYPE SR-4 and SR-4d (V4000 Series)
 - 1. 1.75" H x 4.75"W
 - 2. Metallic two piece raceway with single or divided compartment as called for on plans.
 - 3. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
 - 4. Provide the following fittings:
 - a. Entrance end fitting - nominal maximum dimensions of 4.75"W x 2.75"H x 6.5"L. and 1.25" conduit knockout.
 - b. Back entrance end fitting - same as entrance end fitting with internal radius.
 - c. T fittings to connect to SR-2 (2400 Series) raceway where T section to SR-2 has maximum width equal to SR-2 raceway
 - d. Flat Internal and external elbows with fiber optic radius
 - 5. Design Make: Wiremold V4000 Series raceway, with V4010, V4017FO, V4015FO and V4011FO fittings.
 - 6. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal
- E. TYPE SR-7 (V700 Series)
 - 1. One-piece raceway
 - 2. Color shall be Ivory color and have a durable finish with a scratch-resistant surface that can be field painted.
 - 3. Utilized for wall mounted phones and miscellaneous branch circuit power only.
 - 4. Provide internal and external 90 degree fittings with radius.
 - 5. Provide miscellaneous boxes, extension rings, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.
 - 6. Design Make: Wiremold V700
 - 7. Acceptable Manufacturers: Hubbell, Mono-Systems or approved equal.

2.08 WIRE MESH CABLE TRAY

- A. Cable Tray Finish: Carbon Steel with Zink plating.
- B. Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe/T/Edge T/welded top side wire to protect cable insulation and installers.
- C. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.
 - 1. Mesh: 2 x 4 inches (50 x 100 mm).
 - 2. Straight Section Lengths: 118 inches (3,000 mm).
 - 3. Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray strength; and to allow tray to remain lightweight.
 - 4. Safe/T/Edge: Patented Safe/T/Edge technology on side wire to protect cable insulation and installers' hands.
 - 5. Fittings: Wire mesh cable tray fittings are field/fabricated from straight tray sections, in accordance with manufacturer's instructions and Item 2.3.
 - 6. CF Series Cable Tray Size:
 - 7. Depth: Cable tray shall be available in the following depths:
 - a. [1 inch (30 mm)]
 - b. [2 inches (54 mm)]
 - c. [4 inches (105 mm)]
 - d. [6 inches (150 mm)]
 - 8. Width: Cable tray width will be available in the following widths:
 - a. [2 inches (50 mm)]
 - b. [4 inches (100 mm)]
 - c. [6 inches (150 mm)]
 - d. [8 inches (200 mm)]
 - e. [12 inches (300 mm)]

- f. [18 inches (450 mm)]
- g. [20 inches (500 mm)]
- h. [24 inches (600 mm)]
- 9. Length: Cable tray section length will be 118 inches (3000mm) unless otherwise shown on drawings.
- D. Support cable tray as recommended by manufacture. Provide a safety loading factor of 1.5 for uniformly distributed loads when supported as a simple span in accordance with the NEMA standard listed.
- E. Refer to drawing for additional Cable Tray details and requirements
- F. Design Makes: Legrand Cablofil Wire Mesh
- G. Acceptable Manufacturers:
 - 1. Cooper B/line Flextray
 - 2. Approved equal

2.09 CABLE HANGERS (J-HOOK)

- A. Provide prefabricated, zinc coated, carbon steel hangers designed specifically for UTP and Optical Fiber cable installations.
- B. Hangers shall have open top, rolled edges and a 3" or 4" minimum diameter loop.
- C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.
- D. Design Make CADDY CAT CM

2.10 COMMUNICATIONS/POWER POLES

- A. Provide aluminum multi-service power pole.
- B. Pole shall include 2 electrically isolated channels to act as raceway for communications cabling and future electrical wiring.
- C. Include ceiling trim plate, low voltage entrance fitting, t-bar mounting bracket and carpet / floor grippers.
- D. Design Make: Legrand TPP series or approved equal

2.11 FLOOR BOXES

- A. ACCEPTABLE MANUFACTURERS
 - 1. FSR
 - a. FL-500P-4
 - b. COVER PART# FL-500P-PLP-GRY-C

PART 1 - EXECUTION

3.01 PENETRATIONS

- A. Cutting or Holes:
 - 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Engineer prior to drilling through structural sections.
 - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Engineer as required by limited working space.
- B. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 90 05, JOINT SEALERS.

3.02 INSTALLATION, GENERAL

- A. Install conduit as follows:
 - 1. In complete runs before pulling in cables or wires.

2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
 5. Mechanically continuous.
 6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
 7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
 8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
 9. Conduit installations under fume and vent hoods are prohibited.
 10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 11. Flashing of penetrations of the roof membrane is specified in Section 07 62 00, SHEET METAL FLASHING AND TRIM.
 12. Do not use aluminum conduits in wet locations.
 13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.
- B. Conduit Bends:
1. Make bends with standard conduit bending machines.
 2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
 3. Bending of conduits with a pipe tee or vise is prohibited.
- C. Layout and Homeruns:
1. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Engineer.

3.03 CONCEALED WORK INSTALLATION

- A. In Concrete:
1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
 2. Align and run conduit in direct lines.
 3. Install conduit through concrete beams only when the following occurs:
 - a. Where shown on the structural drawings.
 - b. As approved by the Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
 4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
 - a. Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
 - b. Space between conduits in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
 - c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (3/4 inch) of concrete around the conduits.
 5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.
- B. Furred or Suspended Ceilings and in Walls:
1. Conduit for conductors 600 volts and below:
 - a. Rigid steel, IMC, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
 2. Align and run conduit parallel or perpendicular to the building lines.

3. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.
4. Tightening set screws with pliers is prohibited.

3.04 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 volts and below:
 1. Rigid steel, IMC, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- F. Surface metal raceways: Use only where shown.
- G. Painting:
 1. Paint exposed conduit.

3.05 EXPANSION JOINTS

- A. Conduits 75 mm (3 inches) and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.
- C. Install expansion and deflection couplings where shown.
- D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

3.06 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
 2. Existing Construction:
 - a. Steel expansion anchors not less than 6 mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.
 - b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
 - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.

- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.07 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1".

3.08 COMMUNICATION SYSTEM CONDUIT

- A. Install the communication raceway system as shown on drawings.
- B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.
- C. All conduit ends shall be equipped with insulated bushings.
- D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.
- E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.
- F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.
- G. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- H. All empty conduits located in communication closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
- I. Conduit runs shall contain no more than four quarter turns (90-degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

SIZES OF CONDUIT	RADIUS OF CONDUIT BENDS
TRADE SIZE	MM, INCHES
3/4	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)

2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

- J. Furnish and install 19 mm (3/4 inch) thick fire retardant plywood specified in Section 06 10 00, ROUGH CARPENTRY on the wall of communication closets where shown on drawings. Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.
- K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).
- L. Furnish SMART LB Fittings shall be utilized on all communication conduits. Refer to www.smartlb.com for additional information. Smart LB Die cast Aluminum LB fitting shall be used with Liquidtight, "EMT", "IMC" or "Rigid" Metallic conduit and fittings. Smart LB PVC LB fitting shall be used with Sch 40 rigid PVC, "Sch 80 rigid PVC", "ENT", "PVC Flex Duct", "PVC General Purpose Duct", "PVC Riser Duct", Type NM Liquidtight conduit and "rigid nonmetallic Power and Communication Ducts"
- M. Textile Innerduct (MaxCell):
 - 1. Aboveground, Exterior and Interior Conduit Installations: Outdoor textile innerduct (Standard or Detectable as desired).
 - 2. Interior Exposed Locations
 - a. Non-plenum Areas: Indoor textile innerduct
 - b. Plenum Areas: Plenum-listed indoor innerduct
 - 3. When installed in 4" conduit, use two 3" 3-Cell packs with an additional pull tape on the outside for future pulls in each conduit.
 - 4. Cable Tray: use standard outdoor or indoor textile innerduct

END OF SECTION

SECTION 27 1000
STRUCTURED CABLING GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
1. Contract Documents
 2. Division 00 –Procurement & Contracting Requirements Group
 3. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
 4. Section 27 11 00 – Equipment Room Fittings
 5. Section 27 13 00 – Backbone Cabling
 6. Section 27 15 00 – Horizontal Cabling CAT 6

1.02 REFERENCES

- A. All work shall be performed in accordance with the following Codes and industry Standards, unless noted otherwise:
1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
 2. TIA/EIA 568-B – Commercial Building Telecommunications Cabling Standard, current version.
 3. TIA/EIA 569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
 4. TIA/EIA 606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
 5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
 6. IEEE 241 – IEEE Recommended Practice for Electric Power Systems in Commercial Buildings, pertaining to communication systems.
 7. TIA/EIA 758-A – Customer-Owned Outside Plant Telecommunications Cabling Standard

1.03 WARRANTY

- A. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.

1.04 SUMMARY

- A. This Section includes general requirements specifically applicable to Division 27.
- B. The Contractor shall be responsible for:
1. Providing all additional materials, and the necessary labor and services required to ensure all components of the system are completely installed in accordance with the intent of the Contract Documents.
 2. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
 3. Coordinating the details of facility equipment and construction for all specification divisions that affect the work covered under this Division.
 4. Coordinating all activities with the overall construction schedule.
 5. Developing bill of materials, perform material management and efficient use of the materials whether they are issued by the Contractor, the owner or purchased by the Contractor.
 6. Ensure materials in excess of those required to complete the project are kept in their original condition and packaging for restocking.
 7. Ensure project is properly registered for the specified manufacturer's copper & fiber cable extended warranty programs.
- C. Intent of Drawings:

1. Communications plan drawings show only general locations of equipment, devices, raceways, cable trays, boxes, etc. All dimensioned locations and elevations are approximate. The Contractor is responsible for the field coordination of communications work with the other trades prior to beginning work.
2. The Contractor shall be responsible for the proper placement and routing of equipment, cable, raceways, cable tray, and related components according to the Contract Documents and subject to prior review by Designer.
3. Refer all conflicts between Contract Documents to contractor for resolution.

1.05 DEFINITIONS

- A. Active Equipment: Electronic equipment used to develop various WAN and LAN services.
- B. Backbone: Collective term sometimes used to describe the campus and vertical distribution subsystem facilities and media interconnecting service entrances, communications rooms, and communications cabinets.
- C. Bonding: Permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed on it.
- D. Building Equipment Room (BER): Room in each building used to distribute communications services to Telecommunications Rooms (TR) in the same building. Typically, the BER contains passive equipment used for electrical protection (protectors) and building cross-connect, and active network equipment used for LANs. The BER may also serve the function of a TR.
- E. Cabinet: Freestanding, floor-mounted modular enclosure designed to house and protects rack-mounted electronic equipment.
- F. Cable Tray: Vertical or horizontal open supports usually made of aluminum or steel that is fastened to a building ceiling or wall. Cables are laid in and fastened to the trays. A cable tray is not a raceway.
- G. Campus: Grounds and buildings of a multi-building premises environment.
- H. Channel: The end-to-end transmission path between two points at which application specific equipment is connected; may include one or more links, cross-connect jumper and/or patch cords, and work area station cords. Does not include connection to active equipment.
- I. Communications Equipment Room –See Telecommunications Room (TR)
- J. Cross-Connect: Equipment used to terminate and tie together communications circuits.
- K. Cross-Connect Jumper: A cluster of twisted-pair conductors without connectors used to establish a circuit by linking two cross-connect termination points.
- L. Fiber Optic Distribution Unit (FDU): Cabinet with terminating equipment used to develop fiber optic cross-connect facilities.
- M. Grounding: A conducting connection to earth, or to some conducting body that serves in place of earth.
- N. Hinged Cover Enclosure: Wall-mounted box with a hinged cover that is used to house and protect electrical devices.
- O. Horizontal: Pathway facilities and media connecting Telecommunications Rooms (TR) to Telecommunications Outlets (TO).
- P. Innerduct: Flexible sheath used to enclose cables and protect them from damage. It is commonly used when running fiber optic cable through underground conduits originally designed for large-diameter telephone cables. Max-Cell Innerduct is a fabric based innerduct that enables a higher density of communication cables to be pulled.
- Q. Jack: Receptacle used in conjunction with a plug to make electrical contact between communications circuits, e.g., eight-position/eight-contact modular jacks.
- R. Link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables; one continuous section of conductors or fiber, including the connecting hardware at each end.
- S. Local Area Network (LAN): Data transmission facility connecting a number of communicating devices, e.g., serial data, Ethernet, token ring, etc. Typically, the network is limited to a single site.

- T. Main Equipment Room (MER): The room used to distribute communication services to all Building Equipment Rooms (BER's) on the premises, and to interconnect premises services with the telephone companies. Typically, the MER contains passive equipment used for electrical protection (protectors) and main campus cross-connect, and active equipment used for PBX, WAN, and LAN.
- U. Media: Twisted-pair, coaxial, and fiber optic cable or cables used to provide signal transmission paths.
- V. Mounting Frame: Rectangular steel framework which can be equipment rack or wall mounted to support wiring blocks, patch panels, and other communications equipment.
- W. Passive Equipment: Non-electronic hardware and apparatus, e.g., equipment racks, cable trays, electrical protection, wiring blocks, fiber optic termination hardware, etc.
- X. Patch Cords: A length of wire or fiber cable with connectors on one or both ends used to join communications circuits at a cross-connect.
- Y. Patch Panel: System of terminal blocks or connectors used with patch cords that facilitate administration of cross-connect fields.
- Z. Pathway: Facility for the placement of communications cable. A pathway facility can be composed of several components including conduit, wireway, cable tray, surface raceway, underfloor systems, raised floor, ceiling support wires, etc.
- AA. Private Branch Exchange (PBX): Private communications switching system located on the user's premises. A PBX switches voice and data calls within a building or premises and between the premises and facilities provided by public common carrier networks.
- BB. Protectors: Electrical protection devices used to limit foreign voltages on metallic communications circuits.
- CC. Raceway: An enclosed channel designed expressly for holding wires or cables; may be of metal or insulating material. The term includes conduit, tubing, wireway, underfloor raceway, and surface raceway; does not include cable tray.
- DD. Racks: An open, freestanding, floor-mounted structure, typically made of aluminum or steel, used to mount equipment; usually referred to as an equipment rack.
- EE. Telecommunication Outlet (TO): Connecting device mounted in a work area used to terminate horizontal cable and interconnect cabling with station equipment.
- FF. Telecommunications Room (TR): Distributes communications services to users within a serving zone and interconnects with the BER. Typically, the TER contains passive equipment used for cross-connect and active network equipment used for LANs. TR is sometimes referred to as the communications equipment room.
- GG. Wide Area Network (WAN): Active communications transmission facilities extending beyond the premises.
- HH. Wiring Block: Punch down terminating equipment used to develop twisted-pair cross-connect facilities.

1.06 SYSTEM DESCRIPTION

- A. The Owner will implement a comprehensive integrated communications distribution system, as described in paragraph B below, to provide wiring infrastructure which may be used to support one or more of the following services and systems:
 1. Voice & Data telecommunications.
 2. Wireless systems.
 3. Facilities management systems.
- B. The communications distribution system consists of the following major subsystems, as specified elsewhere:
 1. Inter-building Backbone: The inter-building subsystem refers to all twisted pair and fiber optic backbone communications cabling connecting the Main Building Equipment Room (BER) to each building equipment room (BER) in all buildings on the campus / region. This project includes modification to the campus fiber backbone as shown on the drawings and further detailed in the Specifications.

2. The intra-building subsystem refers to all twisted pair and fiber optic backbone communications cabling connecting the Main Distribution Frame (MDF) to each building Intermediate Distribution Frame (IDF) in the buildings.
 3. Communication Rooms: The communications room contains the distribution subsystem comprised of the passive components used to terminate cabling subsystems and distribute communications services. This subsystem includes installations in the Building Equipment Rooms (BERs), in Telecommunications Rooms (TRs) and Telecommunications Enclosures (TEs). Complete work as shown in the drawings and as specified in Section 271100.
 4. Horizontal Distribution: Horizontal distribution building cable to telecommunication outlets (TOs). Section 271500 is included for termination & testing required for the installation of Cat 6 patch panels in the Telecommunications Rooms (TRs) as described by the drawings and also in the case any additional wiring is identified as necessary as a result of field conditions and approved by the Designer
 5. Work Area Distribution Subsystem: Patch cords, adapters, and devices located between the TO and station equipment. Complete work as shown in the drawings and as specified in Section 271600.
- C. The communications distribution system is based on a combination of, but not limited to, the following communications transmission technologies:
1. 100-ohm 4-pair unshielded twisted-pair cable. (Cat 6)
 2. 100-ohm multi-pair unshielded twisted-pair cable. (Cat 3)
 3. 8.3/125-micron singlemode fiber optic cable.
 4. 8-position telecommunications jacks.
 5. 8-position telecommunications patch panels
 6. Insulation displacement connector (IDC) type field terminated wiring blocks
 7. Outside plant copper splice enclosures
 8. Building entrance protection
 9. Factory Terminated copper patch cords
 10. Rack mount fiber optic hardware
 11. Wall mounted fiber optic hardware
 12. Fiber optic connectors & hardware
 13. Factory terminated fiber optic patch cords
 14. Outside plant fiber splice enclosures
- D. The work locations and limits of work are shown on the drawings.

1.07 DESIGN CRITERIA

- A. Compliance by the Contractor with the provisions of this specification does not relieve him of the responsibilities of furnishing materials and equipment of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.
- B. The following are incorporated into the design:
1. The communications room installations are designed to be as similar as possible.
 2. Electrical protection is provided for all exposed inter-building twisted-pair cabling.
 3. The location of communication rooms is intended to restrict the maximum horizontal subsystem wiring length (defined as a channel between a telecommunications room cross-connect termination field and a served TO) to 295 feet (90 meters).

1.08 WARRANTY

- A. The Contractor shall provide a manufacturer's warranty on the horizontal and backbone systems as specified in Section 27 13 00 and 27 15 00.
- B. In addition to the standard warranty requirements, the Contractor shall provide the following during the warranty period:
1. Within 24 hours after notification of a defect, the Contractor shall start to make the necessary corrections and inform the appropriate Project Manager of the planned corrective actions. The Contractor shall follow this initial contact with continuous effort and complete any required corrective work within 15 days after notification.

1.09 QUALIFICATIONS

- A. Communications Pathway Installation: The Contractor shall have 5 years of documented experience installing raceway and cable tray systems for each of the types and system material components specified in the Contract Documents, e.g., cable tray. In the case of newer technologies that do not have a 3-year history, the contractor shall have documented experience for at least half of the lifetime of the new technology.
- B. The Contractor selected for this project must be certified by the manufacturer of the products installed, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project.
- C. The telecommunications contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer's copper & fiber cable extended warranty programs.
- D. Company certificate & letter from manufacturer stating Contractor's certification is in good standing, shall be included with submittal.
- E. Certified Installer must register project with the specified cable manufacturers, as applicable, and must provide a warranty on the installation workmanship & testing for a length of no less than twenty (20) years.
- F. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical, Category 5e, Category 6 and Category 6a premise distribution systems and have personnel who are adequately trained in the use of such tools and equipment.
- G. A resume of qualification shall be submitted with the Contractor's proposal indicating the following:
 - 1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 - 2. A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.
 - 3. A technical resume of experience for the contractor's Project Manager and on-site installation supervisor who will be assigned to this project.
 - 4. A list of technical product training attended by the contractor's personnel that will install the structured cabling system shall be submitted with the response.
 - 5. Any sub-contractors, who will assist the Contractor in performance of this work, shall have the same training and certification as the Contractor.

1.10 SUBMITTALS

- A. General:
 - 1. Provide ongoing inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
 - 2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of same are clearly indicated and non-applicable portions clearly deleted or crossed out.
 - 3. When the specifications include product descriptions, model numbers, part numbers, etc. that have been superseded, changed, or discontinued, the contractor shall submit a comparable substitution for review by the A/E.
 - 4. The specified manufacturer's copper & fiber cable extended warranty program certificates stating that the communications installer is in good standing in applicable program.
- B. Provide all applicable portions of the following information with the Bid:
 - 1. Documentation establishing qualifications to perform installation functions as required in 1.9 above:
 - 2. Statement demonstrating an understanding of project scope and schedule which includes the following information:
 - a. Where (city, office) the project will be staffed.

- b. Project organizational chart with team names; e.g., project manager, A/Es, principal skilled technicians, and contractors.
- C. Provide all applicable portions of the following information within 10 days after award:
 1. Project schedule in hard copy. Include, at a minimum, major tasks, milestones, dependencies, staffing, and durations for each task.
 2. Contractor shall then work with contractor to merge this schedule into the overall construction schedule.
 3. Provide the following information for materials, components, and equipment to be furnished by the contractor:
 - a. Descriptive literature, manufacturer's specification data sheets, and manuals.
 - b. Individual price and delivery schedules.
 - c. Manufacturer's product test data with indicator arrows. The submittal shall be in the same order as products in 27 11 00, 27 13 00 and 271600.
 - d. Final Performance testing criteria and data for communications distribution system cabling systems.

1.11 DEFINITION OF ACCEPTANCE

- A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:
 1. All submittals and documentation have been submitted, reviewed, and approved.
 2. The complete system has successfully completed all testing requirements.
 3. All Owner staff personnel training programs have been completed.
 4. All punch list items have been corrected and accepted.
 5. Project registration for warranty by manufacturer.

1.12 PROJECT RECORD DOCUMENTS

- A. Provide detailed project record documentation within 30 days after completion of the work.
 1. Maintain separate sets of red-lined record drawings for the communications work which show the exact placement and identification of as-built system components.
 2. Provide communication pathway record drawings which indicate exact placement and routing for all components, e.g., maintenance holes, handholes, conduit, wireway, cable tray, pull boxes, enclosures, telecommunications outlet boxes, etc.
 3. Provide communication room record drawings which indicate exact placement for all components; e.g., conduit, wireway, cable tray, backboards, equipment cabinets, equipment racks, cross-connect equipment, etc.
 4. Provide communication wiring and cabling record "As-Builds" drawings and schedules which indicate exact placement, cable foot marking, routing, and connection details for all components, e.g., twisted-pair and fiber optic cables, splices, cable cross-connect termination locations, enclosures, telecommunications outlets, cross-connect jumpers, patch cords, etc.
 5. Provide network schematics when appropriate.

PART 2 PRODUCTS

2.01 APPROVALS AND SUBSTITUTIONS

- A. Equivalent product(s) may be considered for substitution for those products specified, however, the equivalent product(s) must be approved and show demonstrated and documented equivalence to the product(s) specified. Documentation shall include, but is not limited to: product samples, data sheets, and actual test data. The request for product substitution, and supporting documentation, must be submitted, in writing, prior to submitting the bid. Written approval for product substitution must be submitted with the bid.
- B. Plenum rated cable is to be used throughout the building.

PART 3 EXECUTION

3.01 WORKMANSHIP

- A. Manufactured products, materials, equipment, and components shall be provided, conditioned, applied, installed, connected, and tested in accordance with the manufacturer's specifications and printed instructions
- B. The installation of all system components shall be carried out under the direction of qualified personnel. Appearance shall be considered as important as mechanical and electrical efficiency. Workmanship shall meet or exceed industry standards.

3.02 SERVICE CONTINUITY

- A. Maintain continuity of communications services to all functioning portions of the process or buildings during hours of normal use.
- B. Arrange temporary outages for cutover work with electrical contractor or general contractor. Keep outages to a minimum number and a minimum length of time in order to provide minimum impact.

3.03 LAYOUT AND TOLERANCES

- A. Follow as closely as practicable the design shown on the drawings. Make all necessary measurements in the field to verify exact locations and ensure precise location and fit of specified items in accordance with the drawings. Make no substantial alterations without prior approval of the Designer and the A/E.
- B. Perform all work to the lines, grades, and elevations indicated on the drawings. Provide experienced, competent personnel to locate and lay out the work and provide them with suitable tools, equipment, and other materials required to complete layout and measurement work. Use lasers or other approved methods to establish line and grade.

3.04 CONSTRUCTION REVIEW

- A. The A/E and the Designer will review and observe installation work to ensure compliance by the Contractor with requirements of the Contract Documents.
- B. The Contractor shall inspect and test completed communications installations to demonstrate specified performance levels including the following:
 - 1. Furnish all instruments and personnel required for the inspections and tests.
 - 2. Perform tests in the presence of the A/E and Designer.
 - 3. Demonstrate that the system components operate in accordance with the Contract Documents.
- C. Review, observation, assistance, and actions by the Architect/Engineer (A/E) or General Contractor (GC) shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The A/E's and General Contractor's review and observation activities shall not relieve the contractor from the responsibilities of these Contract Documents.
- D. The fact that the A/E, GC or the owner does not make early discovery of faulty or omitted work shall not bar the A/E, GC or the owner from subsequently rejecting this work and insisting that the contractor make the necessary corrections.
- E. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the A/E, GC or the Owner for an increase in the Subcontract price, or for any payment on account of increased cost, damage, or loss.

END OF SECTION

**SECTION 27 1500
HORIZONTAL CABLING - CAT 6**

PART 1 - GENERAL

1.01 SUMMARY

- A. Horizontal (distribution) communications wiring and connecting hardware from the Telecommunications Room (MDF, IDF) to Telecommunication Outlets / Network Jacks throughout the site.
- B. Cat 6A cabling and associated jacks shall be used for all network devices, IP Cameras, IP Phones, Wireless Access Points, Door Access Controllers, IP Sound System equipment, analog phone lines and as further shown on the drawings.
- C. All Horizontal Station wiring shall be Plenum Rated (CMP).

1.02 RELATED DOCUMENTS

- A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment:
 - 1. Contract Documents.
 - 2. Division 00 – Procurement & Contracting Requirements.
 - 3. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
 - 4. Section 27 10 00 – Structured Cabling General Requirements.
 - 5. Section 27 05 26 – Grounding and Bonding for Communications Systems.
 - 6. Section 27 11 00 – Equipment Room Fittings.

1.03 REFERENCES

- A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
 - 1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
 - 2. TIA/EIA-568-B – Commercial Building Telecommunications Cabling Standard, current version.
 - 3. TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
 - 4. TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
 - 5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
 - 6. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings pertaining to communication systems.

1.04 SYSTEM DESCRIPTION

- A. The horizontal distribution subsystem refers to all intra-building twisted-pair and fiber optic communications cabling connecting Telecommunication Rooms (MTR, ITR's) to telecommunication outlets / network jacks located at individual work areas.
- B. Horizontal cabling may consist of a combination of the following types of cable:
 - 1. Category 6A, (100 Ohm, 4-pair, unshielded twisted pair) cables.
- C. The Horizontal System includes cables, jacks, patch panels, connecting blocks, patch cords, fiber connectors and jumpers as well as the necessary support systems, such as cable managers and faceplates.
- D. Cables may be routed through conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above ceiling tile, and through plenum air-handling spaces above ceiling tile. Coordinate with General Contractor (GC).
 - 1. Furnish and install all materials necessary for a complete and working system.
- E. All Horizontal Station wiring shall be Plenum Rated (CMP).

1.05 WARRANTY

- A. The telecommunications contractor must be an approved certified installer of the cabling manufacturer. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the cabling manufacturer's guidelines. The certified contractor shall have 30% of their technicians trained on copper & fiber installations and testing by the cabling manufacturer.
- B. The copper warranty should guarantee installed static channel (Includes patch cords) performance above the TIA/EIA Standards for Cat 6A cabling systems. The static channel performance tests shall be performed in the field with an approved certification tester in the channel test configuration.
- C. Warranty period shall be for one (1) year.

PART 2 PRODUCTS

2.01 APPROVALS AND SUBSTITUTIONS

- A. All products shall be provided as specified, unless an approved equal is provided.
- B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).
- C. All products shall be "NEW".

2.02 STATION CABLING

- A. Category 6 unshielded twisted pair (Superior Essex DataGain Category 6+)
 - 1. 100 ohm, Category 6A, 22AWG, 4-pair unshielded twisted pair, CMP rated.
 - a. Maximum insertion loss of 2.0 dB/100M at 1 MHz, 19.7 dB/100M at 100 MHz, 32.6 dB/100M at 250 MHz and 48.6 dB/100M at 500 MHz.
 - b. NEXT, PSNEXT, ELFEXT, PSELFEXT margin greater than 5 dB better than ANSI/TIA/EIA category 6 standards requirement
 - c. Cable balance: LCL/TCL greater than 50 dB @ 100 m at 1 MHz, 30.0 dB @ 100m at 100 MHz and 26.0 dB @ 250 MHz. EL TCTL greater than 30 dB @ 100m at 1 MHz, and 5.5 dB @ 100m at 31.25 MHz
 - d. Electrical characteristics must be characterized to 550 MHz.
 - e. Each pair in the cable must be insulated with FEP
 - f. Cable must be third party verified by ETL.
 - g. Superior Essex DataGain Category 6+, Part No. 66-246-xB.
 - h. Color Coding of Cables / Jacks and Patch Cables to be coordinated with Owner prior to ordering. Base pricing on colors listed below

2.03 MODULAR JACKS

- A. Category 6 Jacks: Provide 8 position – 8 conductor keyed, wired in accordance with ANSI/TIA T568B PIN configuration standard to terminate Category 6A UTP cables as specified herein.
 - 1. 8-position modular jack, Category 6A, IDC terminals, T568A/B wiring scheme
 - a. Panduit Mini-Com TX6 Plus, Part No. CJ688-TG
 - 2. Each jack must be stamped or have icons to identify it as CAT 6A.
 - a. Color Coding of Jacks:
 - 1) Blue: Standard Network Devices

2.04 FACE PLATES

- A. Single gang face plate for modular RJ-45 inserts with built in labeling window. Color – Off White Ivory. Panduit Mini-Com Executive Series Faceplates
 - 1. Panduit #CFPE1-WY, 1 port
 - 2. Panduit #CFPE2-WY, 2 port
 - 3. Panduit #CFPE3-WY, 3 port
 - 4. Panduit #CFPE4-WY, 4 port
- B. Blank Inserts – Provide Modular Inserts for any unused face plate opening.

2.05 FIELD TERMINATABLE RJ45

- A. Directly attached to Cat 6 cable for direct plug into IP Classroom Speaker Module
 - 1. Panduit Part No. FP6X88MTG
- B. Provide a cable label on Cat 6 cable to identify IDF patch panel port.

2.06 BISCUIT BLOCKS

- A. Two Port Keystone Surface Mount Blocks
 - 1. 2 port, label field, surface mount, Accepts Panduit Mini-Com TX6 Plus Jacks
 - a. Panduit #CBXQ2

2.07 PATCH PANELS

- A. Modular patch panels
 - 1. 24 port, 8-position modular jack flat panel, high density, Panduit Mini-Com, TX6A Plus Modular jacks, Strain Relief bar (#SRBS19BL-XY), 1U.
 - a. Panduit #CPPL24WBLY
 - 2. 48 port, 8-position modular jack flat panel, high density, Panduit Mini-Com, TX6A Plus Modular jacks, Strain Relief bar (#SRBS19BL-XY), 2U.
 - a. Panduit #CPPL48WBLY

2.08 PATCH CORDS/JUMPERS

- A. Category 6 modular patch cords
 - 1. Factory terminated double ended, 8-position to 8-position, modular, stranded conductors, Category 6, 4 pair.
 - a. Panduit UTPSP1BUY (1 Feet):
 - 1) Blue
 - 2) Provide 10. (IP End Points & Switch connections)
 - b. Panduit UTPSP3BUY (3 Feet): Slimline Booted, Use in Telecom Closets
 - 1) Blue
 - 2) Provide 10
 - c. Panduit UTPSP6BUY (6 Feet): Slimline Booted, Use in Telecom Closets
 - 1) Blue
 - 2) Provide 10
 - d. IP Sound System: EC shall coordinate with Owner when patching into Ethernet network switches.

PART 3 EXECUTION

3.01 GENERAL

- A. Horizontal cabling includes cables, jacks, patch panels, connecting blocks, and patch cords, as well as the necessary support systems, such as cable managers and faceplates.
- B. Contractor shall furnish and install all materials necessary for a complete and working system.
- C. Contractor must be a certified manufacturer installer prior to, during, and through completion of the system installation.
 - 1. Field terminated copper and fiber optic patch cords and jumpers shall not be allowed. All patch cords shall be pre-terminated by the manufacturer.
- D. All work shall be performed in a professional manner.
- E. Install cable after interior of building has been physically protected from the weather and all mechanical work likely to damage cabling has been completed.
- F. Before installing cabling, ensure all cable pathways are completely and thoroughly cleaned:
- G. Inspect conduit, wireway, cable trays, and innerduct installed by others.
- H. Clean any additional enclosed raceway and innerduct systems furnished.
- I. Provide protection for exposed cables where subject to damage.

- J. Provide abrasion protection for any cable or wire bundles, which pass through holes or across edges of sheet metal. Protective bushings shall be used to protect cables.
- K. Cable ties and other cable management clamps shall be no more than hand tightened and shall fit snugly, but not compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices. Plenum spaces require Plenum rated cable ties.
- L. Where possible, route cables in overhead cable trays and inside wire management systems attached to the equipment cabinets and racks. Use plastic ties or ducts to restrain cabling installed outside of wire management systems on racks or in cabinets. Cable trays shall not exceed 50% fill.
- M. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- N. Cable raceways shall not be filled greater than the TIA/EIA-569-A maximum fill for the particular raceway type.
- O. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60-inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids, plumbing pipes, and electrical conduits.
- P. Horizontal distribution cables shall be bundled in groups of no more than the amount of cables designed for by the cable support manufacturer recommends based on cable OD and weight. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- Q. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
- R. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- S. All Conduit Sleeves and wire way trays penetrating fire walls shall have 3M Fire Barrier Pillows installed. Contractor is responsible to place fire barrier pillows on all existing penetrations that will be reused to run new cable and all new penetrations required for the new cable installation. Fire barrier Pillows shall be placed per manufacturer's recommendation to create a 2-hour fire barrier.

3.02 UNSHIELDED TWISTED PAIR CABLE INSTALLATION PRACTICES

- A. Cable shall be installed in accordance with manufacturer recommendations and best industry practices.
- B. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- C. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- D. The cable's minimum bend radius and maximum pulling tension shall not be exceeded Bend radius for UTP = 4 X Cable OD, FTP = 8 X Cable OD.
- E. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- F. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable. Separation from Power Lines:
- G. Provide the following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
- H. Open or Nonmetal Communications Pathways:
 - 1. 12 inches from electric motors, fluorescent light fixtures, and unshielded power lines carrying up to 3 kVA.
 - 2. 36 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
 - 3. 48 inches from large electrical motors or transformers.
- I. Grounded Metal Conduit Communications Pathways:
 - 1. 2 1/2 inches from electrical equipment and unshielded power lines carrying up to 2 kVA.

2. 6 inches from electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA.
3. 12 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
4. 3 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA.
5. 6 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying more than 5 kVA.

3.03 UNSHIELDED TWISTED PAIR TERMINATION

- A. Cables shall be coiled to house the cable coil without exceeding the manufacturers bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored; Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
- B. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B.1 document, manufacturer's recommendations and best industry practices.
- C. All 4 pair cables shall be terminated on the jack and patch panels using T568-B wiring scheme.
- D. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- E. Bend radius of the horizontal cable shall not be less than 4 times the outside diameter of the UTP cable. 8 times for FTP cables.
- F. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- G. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- H. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- I. The cable jacket shall be maintained as close as possible to the termination point. Cable shall not have more than 1.0" removed.

3.04 TESTING PROCEDURES

- A. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- B. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, the manufacturer's procedures and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.
- C. Cables, jacks, connecting blocks, and patch panels shall be in their final position with the building energized.
- D. All Unshielded Twisted Pair cables shall be tested as follows:
 1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using an approved certification tester (Fluke or Agilent) for category 6 performance compliance as specified in ANSI/TIA/EIA-568-B.2-1.
 2. Follow the Standards requirements established in ANSI/TIA/EIA-568-B .1, B.2-1.
 3. Testing shall be accomplished with an approved certification tester (Fluke or Agilent)
 4. The basic tests required are:
 - a. Wire Map
 - b. Length (feet)
 - c. Insertion Loss (dB) (Formerly Attenuation)
 - d. NEXT (Near end crosstalk) (dB)
 - e. Return Loss (dB)
 - f. ELFEXT (dB)

- g. Propagation Delay (ns)
 - h. Delay skew (ns)
 - i. PSNEXT (Power sum near-end crosstalk loss) (dB)
 - j. PSELFEXT (Power sum equal level far-end crosstalk loss) (dB)
5. Cat 6 shall be tested to a Cat 6 auto test to 250 Hz.
6. All test results shall be provided in the approved certification testers original software format on a CD, with the following minimum information per cable:

2.05.1.1.1.1.1 Circuit ID

2.05.1.1.1.1.2 All information from 3.4D.4 above.

2.05.1.1.1.1.3 Test result, "Pass" or "Fail"

2.05.1.1.1.1.4 Date and Time of test

2.05.1.1.1.1.5 Project Name

2.05.1.1.1.1.6 NVP

2.05.1.1.1.1.7 Version of software

Note: No asterisk * will be accepted. These results shall be retested and submitted after a PASS is received.

- E. A software copy of the test results, in the original tester software format, shall be provided to the Owner and manufacturer.
- F. Contractor shall provide a fully functional version of the tester software for use by the Owner in reviewing the test results.
- G. Any failed test results that cannot be remedied through re-termination (as in the case of reversed or split pairs), must be reported in writing to the Owner immediately, along with a copy of the test results.

3.05 LABELING

- A. All horizontal cables are to be labeled using a machine printed label at each end of the cable at approximately 12 inches of the termination point, and again at approximately 48 inches from the termination point. Handwritten labels shall not be used.
- B. All patch panel ports and telecommunication outlet ports shall be labeled with the cable identifier.
- C. The labels shall denote the Telecommunications outlet ID, as well as the unique cable number for that Telecom Outlet, i.e. A-001-A for cable number 1, A-001-B for cable number 2, and so forth. Owner may provide specific labeling requirements coordinate with owner.
- D. Note all labeling information on the as-built drawings.

END OF SECTION

SECTION 27 4166
AUDIO AND VIDEO SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Special Conditions and Division-1 Specification sections, apply to work specified in this section.

1.02 SUMMARY

- A. This section covers the auditorium audio and video systems

1.03 GENERAL REQUIREMENTS

- A. This project is the provision and installation of new systems within a renovated venue. All bidders shall fully inform themselves of the conditions under which the work is to be performed. No additional compensation or time extension will be given for conditions of which bidder could have been fully aware prior to bid
- B. The systems and all components shall conform to all applicable code requirements and shall be furnished and installed in conformance to industry standards of operation and practices. All materials, arrangements, and procedures shall comply with applicable code requirements.
- C. The contractor is responsible to ensure that the system and all system components, fixtures, equipment, devices, wire, terminations, field assemblies (including custom assemblies) etc. pass all required inspections by the local authority having jurisdiction.
- D. Any errors, omissions, or ambiguities found in these documents do not relieve the contractor from the responsibility of providing all items necessary for complete, safe, fully functional systems. Any errors, omissions, or ambiguities shall be brought to the attention of the Architect/Engineer of Record, Construction Manager, Owner, and/or Theater Consultant for clarification.
- E. The drawings and specification when taken together communicate the design intent of the system. The contractor is responsible for all engineering, procedures, drawings, equipment, material, means and methods, and contract administration necessary to fully and completely furnish and install the system contemplated by these documents.
- F. Anything shown on the drawings or included in this specification shall be considered as part of both documents.
- G. Any item of equipment or hardware that may not be specifically shown on the drawings or specified herein but required for proper system operation or installation shall be furnished and installed and be of the highest quality available.
- H. The contractor shall assume full responsibility for a complete operating installation, in the required location, in accordance with the contract documents.

1.04 SCOPE OF WORK

- A. This section covers the Auditorium AV system and the Gym sound system.
- B. This section requires the fabrication, furnishing, delivery, installation, testing of the audio and video systems, equalization of the audio system, and programming of the control systems as indicated on the drawings and specified herein.
- C. Provide a professional quality, complete and properly operating system in every respect and detail.
- D. Employ the most current best standard practices for all aspects of work.
- E. Examine the plans in detail to familiarize with the scope of the work.
- F. Provide all materials, equipment, procedures, labor, tools, scaffolds, and incidentals necessary to the scope of work.

- G. Any item of equipment or hardware that may not be specifically shown on the drawings or specified herein but required for proper system operation or installation shall be furnished and installed and be of the highest quality available.
- H. Provide all necessary equipment for the complete sound and video system installation as shown on the drawings and specified herein.
- I. Provide speaker, plates, panels, millwork, enclosures, baffles, grille cloth, and all other items under this contract in a manner and color as approved by the architect.
- J. No changes will be allowed for any issue that could have or should have been known at the time of bid. This includes but is not limited to discontinued products.
- K. The contractor is solely responsible for meeting all codes and regulations and for the complete code compliance of the finished system.
- L. The contractor acknowledges that the consultants' opinion is final.
- M. Coordinate fully with the electrical contractor.

1.05 WORK INCLUDED

- A. Coordinate the system conduit and device locations with the electrical contractor.
- B. Deliver to the job site, and coordinate the installation of, the specialty equipment with the electrical contractor.
- C. Furnish, install, and terminate all wire.
- D. Furnish and install all system devices.
- E. Provide all required shop drawings and submittals.
- F. Provide system manuals.
- G. Provide system warranty.
- H. Provide system training.
- I. Procure of all required permits.
- J. Furnish all non-standard back boxes shown on the electrical drawings to the electrical contractor.
- K. Furnish sequencing panel board to the electrical contractor.
- L. Provide all DSP programing, control system programing, system tuning and complete configuration of all components.
- M. Provide control system programming in a manner that meets all the owner's needs and request in terms of function and usability. This includes owner suggested modifications post system checkout.
 - 1. Provide Crestron source code
 - 2. Provide Crestron assembled installed code
 - 3. Crestron control pages must be controllable via an iPad
 - 4. In addition to the touch panel(s), provide both executable and web-based x-panel interfaces
- N. Provide all mounting and attachments of all speakers, projectors, projection screens, displays, TVS, and equipment unless specifically indicated otherwise.
- O. Coordinate all wireless microphone frequencies.
- P. Equipment Power
 - 1. Provide power distribution within all equipment racks.
 - 2. Furnish and install a jbox in the top of each rack for the electrical contractor to "make up" to.

3. Provide power strips, power outlet boxes, internal rack wiring and everything necessary to power up all rack equipment.
 4. Provide power cables for all portable racks and equipment.
- Q. Other requirements.
1. All RJ45 jacks and portable cables shall be color coded according to function.
 2. All RJ45 portable cable shall be heavy duty service type – Wireworks TacCat6 or equal.
 3. All RJ45 jacks shall be Nuetrik EtherCON.

1.06 WORK TO BE COORDINATED WITH OTHERS

- A. The following items of work, if required, are included in other sections and must be reviewed by the AV system sub-contractor for impact on this work:
1. Necessary conduit and raceway runs.
 2. Stage flooring.
 3. Theatrical stage lighting and electrical connections, electrical contractor supplied junction and back boxes, wiring to power sources, and wiring to all other electrically powered devices.
 4. Front of house catwalks.
- B. The AV system sub-contractor shall specifically coordinate the placement and sizes of conduit relating to this work and shall specifically review and approve the conduit rough-in in time to advise all parties of needed changes, omissions, etc. The AV system sub-contractor shall report this successful coordination in writing to the owner's representative. Failing this, the following will be enforced:
1. The AV system sub-contractor shall provide and install any additional conduits required for the hookup, proper location and proper isolation of the various cable / signal types and equipment in the systems. The AV system sub-contractor must coordinate his conduit installation with those installed by the electrical contractor. All conduits shall be sized to their intended fill plus fifty percent.
- C. The AV system sub-contractor shall at all times coordinate his work with the other trades to ensure smooth progress of work and satisfactory final results.

1.07 AV SYSTEM SUB-CONTRACTOR QUALIFICATIONS

- A. Only qualified AV system sub-contractor shall be used.
- B. The intention is that the work of this section will be contracted to a single firm, referred to as the AV system sub-contractor.
- C. The AV system sub-contractor shall be a systems integrator who regularly engages in the furnishing, installation and servicing of professional systems of similar nature, size, scope and complexity to that contemplated by this specification. The AV system sub-contractor shall have done so for a period of not less than five years preceding the bid date.
- D. The AV system sub-contractor shall have maintained for the five years preceding the bid date, a suitably staffed and equipped service organization which has continuously offered maintenance and repair services for systems of the nature, size, scope and complexity to that contemplated by this specification.
- E. All liens must be satisfied for at least five years.
- F. The AV system sub-contractor shall be licensed and insured.
- G. The AV system sub-contractor shall be a factory authorized dealer for all major system components:
1. Amplifiers

2. Control system
 3. Digital signal processor
 4. Mixing console
 5. Speakers
 6. Video projector
 7. Wireless microphones
- H. The contractor shall demonstrate to the satisfaction of the owner, through exhibits presented with his bid, that the sound contractor has a history to indicate the following:
1. Statement of current company capabilities and ownership.
 2. Statement of company history. Include a breakdown by percentage of gross sales of all business activities the contractor is involved in for each of the last 5 years (e.g. system installation = 30%, box sales = 40%, equipment rentals = 20%, design and other professional services = 10%, etc).
 3. Previous experience: Provide a list of four installations of the type and size contemplated by these specifications, currently in use as originally installed, in which a theatre / system consultant was involved, completed in the last 5 years and the following information regarding each installations:
 - a. Name and address of each installation facility.
 - b. Facility owner and telephone number.
 - c. Name, address, and phone number of a person regularly employed by the owner, who is familiar with the operation of the systems and who has no connection or business connections with the contractor except as the contractor shall fully disclose
 - d. Name, address, and phone number of the theatre / system consultant, along with the names of all the consultant's personal directly involved.
 - e. System shop drawing - These will be returned if the contractor provides a call tag or return postage.
 - f. Owner's manual drawing - These will be returned if the contractor provides a call tag or return postage.
 - g. System as-built drawings drawing - These will be returned if the contractor provides a call tag or return postage.
 - h. List of contractors personal involved with each persons responsibility on the project.
 - i. Name, address and phone number of the general contractor, along with the names of all key GC personal directly involved.
 - j. Name address and phone number of the electrical contractor, along with the names of all key EC personal directly involved.
 4. Key Personnel: For each of the key personnel listed below; Include individual's name, title, and number of continuous years of service to contractor. Include a biography detailing industry experience, and role within organization (include only full-time/regular staff employees; not independent contractor, freelance, or temporary positions). List all industry certifications held, training courses attended, and continuing education credits, including dates of attendance. List recently completed projects, scope of project, and completion dates.
 - a. Project Manager
 - b. Senior Technician
 - c. Service Manager

- d. Other Department Staff – Include size of staff, and experience of each staff member.
5. Replacement and Spare Parts Inventory – Provide detailed list of primary replacement parts, components, and spares typically held in inventory.
6. Test Equipment and Physical Plant – Include an inventory of all test facility equipment owned and used regularly by the Service Department. Provide description of physical plant and space utilization.
7. Statement of adequate plant, equipment, test facilities and inventory to pursue the work properly and perform in a timely fashion.
8. Copies of all business and professional licenses and insurance certificates

PART 2 - PRODUCTS

2.01 ALTERNATES

- A. In no case will equipment or materials of lesser design or workmanship be acceptable. Only those materials and equipment listed in this specification will be considered unless prior approval is sought and received.
- B. Substitutions: When a specific piece of equipment specified has been discontinued and/or replaced by a new model, substitution will be acceptable when:
 1. Submission of complete data on the new model or substitute has been approved by the owner prior to equipment acquisition. Data shall include list pricing for specified and replacement equipment.
 2. Substitute equipment or the replacement of rejected equipment shall be at the sole expense of the AV system sub-contractor.
 3. After submittals have been approved there will be no cost to the owner for any required replacement equipment under any circumstances.
- C. Should the AV system sub-contractor proposed and receive approval for the use of alternative wire and cable which requires additional conduit, the AV system sub-contractor will be solely responsible for the installation of such conduit.

2.02 GENERAL REQUIREMENTS

- A. The major items of equipment shall be furnished in the quantity as on the drawings and the quantity as specified herein.
- B. When documents list several acceptable manufacturers for a particular item of equipment, more than one of which is to be provided, the AV system sub-contractor shall supply all of those similar items of equipment from one manufacturer.
- C. The AV system sub-contractor will provide necessary millwork, enclosures, baffles, grille cloth, wall plates, and any other item furnished under this contract not specifically noted otherwise herein or on the drawings in a manner and color as approved by the owner.
- D. Any item of equipment or hardware that may not be specifically shown on the drawings or specified herein but required for proper sound system operation or installation shall be furnished and installed and be of the highest quality available.
- E. All equipment, where applicable standards have been established, shall be listed by a nationally recognized testing labs and must bear a compliance label with delivered to the job.
- F. If so required by the local authority having jurisdiction, anything not arriving at the job bearing a UL label shall be field inspected and label by a nationally recognized testing laboratory recognized and approved by the local authority having jurisdiction. This extends to field assemblies.
- G. The performance of all equipment must meet the most recently published manufacture's data sheet

- H. Provide all power supplies, POE injectors, rack power distribution, power cabling and related equipment.
- I. Provide all software, apps, and drivers:
 - 1. Shure Wireless Work Bench
 - 2. DSP setup / editor
 - 3. Console App
 - 4. Console editor
 - 5. Dante controller software
 - 6. Amp control software
 - 7. Crestron source code
 - 8. Crestron assembled code
- J. The system has been engineered and coordinated to a very high standard. If alternates are not listed in the equipment list below there are no known equals.
- K. Provide the follow equipment in the quantities shown in the contract drawings:
 - 1. LGT-2: Local Control Light
 - a. Dialight 557 Series red LED panel mount indicator light with voltage determined by DSP logic output.
 - 2. SWT-2: Local Control Switch
 - a. Schurter MSM 22 Series, non-illuminated, momentary action, micro switch
- L. Provide all equipment shown on the contract drawings.
 - 1. All specialty back boxes listed on the electrical drawings.
 - a. CMP1 = Whirlwind black powder coated surface mount 12x12x6 backbox with either Whirlwind WFS flush mount wall frame + custom panel or Whirlwind WFS surface mount wall frame + custom panel. Equal Wireworks Guardian Panel Mounts + custom panels will be accepted.
 - b. ICSS = Flush mount wall backbox for Clear-Com wall mount speaker stations.
- M. Panels: All panels are made of 1/8" thick Aluminum plate, brushed anodized black and sealed. All controls and connectors will have engraved labels. The minimum allowable label size is 1/8"s. All labels will be back filled with white paint. All connectors are mounted with machine hardware. All panel layouts and labels must be submitted and approved prior to construction, the panels shown in the drawings are typical only. All "D-shape" connectors shall be Neutrik where available. All 6 pin connectors shall be Switchcraft compatible.
 - 1. Coordinate all plate and panel colors with architecture.
- N. Microphone Receptacles: The above general requirements for panels apply to the construction of Microphone Receptacles as well. See the contract drawings for quantity and type required.
- O. Monitor Speaker Receptacles: The above general requirements for panels apply to the construction of Monitor Speaker Receptacles as well. See the contract drawings for quantity and type required.
- P. Tie Line Receptacles: The above general requirements for panels apply to the construction of Tie Line Receptacles as well. See the contract drawings for quantity and type required.
- Q. Intercom Connection Receptacles: The above general requirements for panels apply to the construction of Intercom Connection Receptacles as well. See contract drawings for quantities and types required.
- R. Speaker Receptacles: The above general requirements for panels apply to the construction of Speaker Receptacles as well. See the contract drawings for quantity and type required.

- S. Custom panels: See drawings for required components.
- T. Connectors:
1. All XLR cable connectors are Neutrik "XX" series, black bodies, and silver contacts unless otherwise indicated.
 2. All XLR chassis connectors are Neutrik "DLX" series, black bodies and silver contacts unless otherwise indicated.
 3. All 6 pin XLR connectors for intercom must be "Switchcraft compatible"
 - a. Six pin chassis mount male connector = Neutrik NC6MSD-L-1
 4. All D-shaped RJ45 jacks are Neutrik etherCON CAT6A, shielded, feedthrough, black housing
 5. All RJ45 plugs are Neutrik etherCON CAT6A, black bodies = Neutrik NE8MX6-B or NE8MX6-B-T depending on conductor size.
 - a. Install Neutrik XXR-* color coding rings on all cable mount plugs. Ring color shall match corresponding jack color.
 6. All speaker cable connectors are Neutrik speakON series.
 - a. All four pole chassis mount connectors are Neutrik NL4MP-UC
 - b. All four pole cable mount connectors are Neutrik NL4FC
 - c. All eight pole chassis mount connectors are Neutrik NLTMP-BAG
 - d. All eight pole cable mount connectors are Neutrik NLT8FX-BAG
 7. All RCA chassis connectors are Neutrik D-shaped housing, black chrome bodies, solder tabs
 - a. Stereo left = white isolation washer Neutrik NF2D-B-9
 - b. Stereo right = red isolation washer Neutrik NF2D-B-2
 8. All 75 Ω BNC female chassis connectors for analog video, all SDI formats, and coax digital audio are Neutrik NBB75DFIX (isolated, UHD, feed through, antralo plated, D-shape) or Canare BCJ-JRUDBK.
 9. All user accessible 75 Ω BNC male cable mount connectors are Neutrik rearTWIST UHD series where compatible coax cables are present.
 - a. Belden 4731RBUHD3 for Belden 7731WB
 - b. Neutrik NBNC75ZV14X for Belden 4794R and Canare L5.5CUHD
 - c. Neutrik NBNC75BTU11 for Belden 4694F
 10. All 75 Ω BNC male cable mount connectors that are not user accessible – use cable manufacture's matching BNC connector.
 11. All 50 Ω BNC female chassis connectors for antenna jacks are Ace Backstage model C-25121 isolated feed through BNC connector mounted in black plastic universal D sized adaptor plate.
 12. All 50 Ω BNC male cable mount connectors – use cable manufacture's matching BNC connector.
 13. All F type female chassis connectors are Ace Backstage model C-25104 isolated feed through F type connector mounted in black plastic universal D size adaptor plate.
 14. All F type male cable mount connectors – use cable manufacture's matching F connector.
 15. All HDMI chassis mount pass through connectors are Neutrik NAHDMI-W-B

16. DisplayPort chassis mount pass through connectors are either Extron MAAP black DisplayPort female to female pigtail modules part # 70-676-12 or Crestron MP-WP162-B (this is a single gang "Decora" size / style device) depending on size.
 17. All USB chassis mount pass through connectors are Neutrik NAUSB3-B
 18. All 1/4" phone jacks are Neutrik NJ3FP6C-BAG (3 pole, metal housing, silver contacts)
 19. All fiber optic connectors are as required by each manufacturer
- U. System Wire:
1. All wiring in a conduit, where the conduit is located in the slab or on grade, must be rated for wet location.
 2. Where West Penn Wire part numbers are specified, equivalents by Belden will be approved provided no change in conduit size is required.
 3. Where Belden part numbers are specified, equivalents by West Penn Wire will be approved provided no change in conduit size is required.
 4. All low Z speaker runs and all monitor / effects speaker receptacles:
 - a. Wire enclosed in conduit, racks, or speaker enclosures – twisted pairs of 10 A.W.G. THWN
 - b. Wire enclosed in conduit; where the conduit is not in a wet location, racks, speaker enclosures - twisted pairs of 10 A.W.G. THWN
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables:
 - 1) Two conductor = 12/2 SJO
 - 2) Four conductor = Whirlwind W12/4
 - 3) Eight conductor = Whirlwind W13/8
 - d. Wire both pairs / all four poles of all four pole Neutrik speakON jacks from field jacks back to the amp racks/ amp outputs / patchabay jacks.
 - e. Wire all four pairs / all eight poles of all eight pole Neutrik speakON jacks from field jacks back to the amp rack / amp outputs / patchabay jacks.
 5. All 70 volt speakers, volume controls, priority attenuators, priority attenuator relays:
 - a. Wire enclosed in conduit; where the conduit is in a wet location - West Penn Wire AQC 225
 - b. Wire enclosed in conduit; where the conduit is not in a wet location, racks, speaker enclosures - West Penn Wire 225
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Whirlwind W16GA
 6. All mic, analog line, and DC signaling:
 - a. Wire enclosed in conduit; where the conduit is in a wet location – Belden 5500F1 or West Penn Wire AQC 291
 - b. Wire enclosed in conduit; where the conduit is not in a wet location, and racks – West Penn Wire 291
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Whirlwind W1192A-BK Star Quad
 7. All intercom:
 - a. Wire enclosed in conduit; where the conduit is in a wet location - Belden 5300F1 + an additional green with yellow strip 12 A.W.G. THWN wire or West Penn Wire AQC 293 + an additional green with yellow strip 12 A.W.G. THWN wire.

- b. Wire enclosed in conduit; where the conduit is not in a wet location, and racks – West Penn Wire 293 + an additional green with yellow strip 12 A.W.G. THWN wire.
 - c. The additional 12 A.W.G THWN wire shall be connected in parallel with the drain wire of the shielded twisted pair cable.
 - d. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Whirlwind W1192A-BK Star Quad
8. All twisted pair AES/EBU:
- a. Wire enclosed in conduit; where the conduit is not in a wet location, and racks - West Penn DA2401.
 - b. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Whirlwind W1800F
9. All Dante, AV control network, CAT6A tie line, Ethernet, One-Link, RDL Twisted Pair, TCP/IP, and other category type cabling not specified elsewhere:
- a. Wire enclosed in conduit; where the conduit is in a wet location - Belden OSP6AU
 - b. Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Belden 10GX32
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers - Wireworks TacCat6
 - d. Patchbay cables - Belden 10GX32
10. ALS transmitter antenna = RG58 50 Ω :
- a. Wire enclosed in conduit; where the conduit is in a wet location - Belden 7808WB
 - b. Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Belden 7807R
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Belden 7807R
11. Wireless microphone antenna = RG8 50 Ω :
- a. Wire enclosed in conduit; where the conduit is in a wet location - Belden 7810WB
 - b. Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Belden 7810A
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Belden 7810A
12. Analog video, all SDI formats, and coax digital audio = RG11 75 Ω :
- a. Wire enclosed in conduit; where the conduit is in a wet location - Belden 7731WB
 - b. Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Belden 4794R
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Belden 4694F
13. Modulated RF TV distribution = RG6 75 Ω
- a. Wire enclosed in conduit; where the conduit is in a wet location – West Penn Wire AQC806

- b. Wire enclosed in conduit; where the conduit is not in a wet location, and racks – West Penn Wire 806
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – West Penn Wire 806
14. HDMI:
- a. Wire enclosed in conduit; where the conduit is not in a wet location, and racks - Extron HDMI Ultra Series
 - b. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables - Extron HDMI Ultra Series
15. Crestron DM:
- a. Wire enclosed in conduit; where the conduit is in a wet location - consult Crestron
 - b. Wire enclosed in conduit; where the conduit is not in a wet location, and racks – Crestron DM-CBL-ULTRA-NP
 - c. Wire not enclosed in conduit or racks, service type cables, connection jumpers, and patch cables – Crestron DM-CBL-ULTRA-PC
16. Fiber:
- a. OM3
- V. Internal Rack Power Wiring:
- 1. Provide all power wiring, devices, hardware, receptacles, etc. as required to power wall equipment within each rack.
 - 2. Provide a junction box located at the top of the rack for connection to circuiting by the electrical contractor.
 - 3. Provide power cables for all portable racks.
- W. Power Sequencing Panel Board: Provide to the electrical contractor for installation the Lyntec Power Sequencing Panel Board shown and described on the system drawings.
- 1. RCP 341 main panel
 - 2. SGX20-10 surge protection side car
 - 3. Main breaker
 - 4. Branch breakers
- X. Auditorium Portable Equipment: Provide the following equipment that is not shown on the contract drawings:
- 1. Show Monitor Mic:
 - a. Mount a Shure Beta 87A from the front of house catwalk pointed toward the stage. This is a permanent installation and will require a custom assembly of mic mounting hardware. Typically a mounting flange with a small boom arm will be required to place the mic out into the room and rigidly hold it in position. Fishing line or other similar methods will not be accepted.
 - 2. Mixing Console Accessories
 - a. Console LED lights (as many as possible)
 - b. Console Cover
 - 3. Assisted Listening
 - a. 40 @ Listen Technologies model LR-5200-072 advanced intelligent DSP RF receiver
 - b. 40 @ Listen Technologies model LA-401 universal ear speaker

- c. 15 @ Listen Technologies model LA-430 intelligent ear phone / neck loop lanyard
 - d. 4 @ Listen Technologies model LA-380 intelligent 12-unit charging / carrying case
 - e. 3 @ Listen Technologies model LA-303 multi-lingual assistive listening notification sign
 - f. 40 @ Listen Technologies model LA-365 replacement rechargeable Li-Ion battery
 - g. 4 @ Listen Technologies model LA-381 intelligent 12-unit charging tray
 - h. 1 @ Listen Technologies model LA-202 LE venue awareness kit
4. Intercom belt pack.
 - a. 6 @ Clear-Com RS-701.
 5. Intercom single muff headset.
 - a. 6 @ Clear-Com CC-300
 6. Intercom Cables: Whirlwind MKQ series in black.
 - a. 4 @ 20 feet
 - b. 4 @ 30 feet.
 - c. 2 @ 50 feet.
 7. Wireless Microphones and Accessories
 - a. 6 @ Shure ULXD2/B87C handheld transmitter with Beta 58 head. Include a SB900A lithium-ion rechargeable battery pack and standard accessories with each transmitter
 - b. 16 @ Shure ULXD1 belt-pack transmitter. Include a Countryman E6 ear set microphone (with mating connector, light beige color, omni pattern, W6 sensitivity), a SB900A lithium-ion rechargeable battery pack, and standard accessories with each transmitter
 - c. 22 @ Shure SB900A rechargeable lithium-ion batteries for spares
 - d. 2 @ Shure SBC200-US dual docking recharge station with US power supply
 - e. 6 @ Shure SBC200 dual docking recharge station
 - f. 2 @ Shure SBC800 8-up battery charger
- Y. Gym Portable Equipment: Provide the following equipment that is not shown on the contract drawings:
1. Mixing Console Accessories
 - a. Console LED lights (as many as possible)
 - b. Console Cover
 2. Assisted Listening
 - a. 40 @ Listen Technologies model LR-5200-072 advanced intelligent DSP RF receiver
 - b. 40 @ Listen Technologies model LA-401 universal ear speaker
 - c. 15 @ Listen Technologies model LA-430 intelligent ear phone / neck loop lanyard
 - d. 4 @ Listen Technologies model LA-380 intelligent 12-unit charging / carrying case

- e. 3 @ Listen Technologies model LA-303 multi-lingual assistive listening notification sign
 - f. 40 @ Listen Technologies model LA-365 replacement rechargeable Li-Ion battery
 - g. 4 @ Listen Technologies model LA-381 intelligent 12-unit charging tray
 - h. 1 @ Listen Technologies model LA-202 LE venue awareness kit
3. Intercom belt pack.
 - a. 3 @ Clear-Com RS-701.
 4. Intercom single muff headset.
 - a. 3 @ Clear-Com CC-300
 5. Intercom Cables: Whirlwind MKQ series in black.
 - a. 3 @ 30 feet.
 - b. 1 @ 50 feet.
 6. Wireless Microphones and Accessories
 - a. 4 @ Shure ULXD2/B87C handheld transmitter with Beta 58 head. Include a SB900A lithium-ion rechargeable battery pack and standard accessories with each transmitter
 - b. 4 @ Shure ULXD1 belt-pack transmitter. Include a Countryman E6 ear set microphone (with mating connector, light beige color, omni pattern, W6 sensitivity) a SB900A lithium-ion rechargeable battery pack, and standard accessories with each transmitter
 - c. 6 @ Shure SB900A rechargeable lithium-ion batteries for spares
 - d. 1 @ Shure SBC200-US dual docking recharge station with US power supply
 - e. 2 @ Shure SBC200 dual docking recharge station
 - f. 1 @ Shure SBC800 8-up battery charger
 7. Microphones. Provide a mic clip for each mic.
 - a. 6 @ Shure SM-58
 - b. 2 @ Shure SM-57
 8. Microphone Stands & Accessories.
 - a. 4 @ Atlas Sound MS20E
 - b. 6 @ K&M KM210/91 black, mic stand w/boom
 9. Mic Cables: Whirlwind MKQ series in black.
 - a. 4 @ 10 feet
 - b. 4 @ 30 feet.
 - c. 4 @ 50 feet.
 10. Monitor and Portable Speakers.
 - a. 4 @ Electro-Voice ZX3 w/ stand sockets
 - b. 4 @ Ultimate Support TS-90B speaker stands
 11. Speaker Cables.
 - a. 8 @ Whirlwind NL-4-50
 - b. 4 @ Neutrik NL4MM
 12. Audio Interfaces and Cables:

- a. 1 @ Radial Engineering JDI Jensen equipped 1 channel passive instrument direct box
 - b. 1 @ Radial Engineering BT-PRO V2 bluetooth interface
 - c. 1 @ Radial Engineering ProAV2 stereo multimedia direct box
 - d. 6 @ Whirlwind MKQ mic cable 6 feet
 - e. 6 @ Whirlwind MKQ mic cable 25 feet
 - f. 8 @ Whirlwind Leader Elite ¼" TS instrument cable 6 feet
 - g. 2 @ Whirlwind MST06US stereo 3.5mm to 3.5 mm cable
13. Headphones.
- a. 1 @ Sony MDR-7506

PART 3 - EXECUTION

3.01 STANDARDS COMPLIANCE

- A. Comply with all local building codes.
- B. In the absence of specific local codes, comply with the National Electrical Code (NFPA-70) as applicable to installation and construction of communication and control equipment.
- C. Where not in conflict with local building codes or the National Electrical Code comply with industry standard professional practices.
- D. Installation practices shall be in accordance with OSHA Safety and Health Standards

3.02 SUBMITTALS:

- A. Within thirty days of the bid award and prior to beginning work, prepare and submit shop drawings and product data cut sheets to the architect for approval
- B. All of the following must be submitted at the same time:
 - 1. Shop Drawings: Complete shop drawings details and complete on all phases of installation including a minimum of:
 - a. Device location plan drawing(s)
 - 1) Location of all devices
 - 2) Confirm box type – surface or flush – as acceptable and constructible based on box depth and wall construction
 - 3) Confirm color of all surface mount boxes
 - b. Control booth layout – plan section and elevation drawings showing:
 - 1) All equipment
 - 2) All connection plates
 - 3) Panduit wire duct if required
 - 4) Free cable routing and required cable pass throughs / grommets
 - 5) Conduit
 - 6) Junction boxes
 - c. System wiring diagram:
 - 1) Show Dante ID and other setup info
 - 2) Show wireless frequency coordination
 - 3) Show IP address management
 - 4) Show RF levels on TV distribution system
 - 5) Show EDID information and management
 - 6) Make and model of all equipment
 - 7) All connection points on each piece of equipment
 - 8) All wire types

- 9) All connector types
- 10) All cable labels
- d. Rack drawings
 - 1) Elevations showing all equipment labels
 - 2) Section showing all equipment depth and rack rail locations
 - 3) Power details
- e. Details of all connection plates and custom panels
- f. Mounting and rigging details for all equipment
- g. Drawing showing the projector, the screen, the throw distance and all lens calculations in both plan and section
- h. Mountings and Attachments: Scale plan, section and elevations drawings of all proposed enclosures and speaker mounting or rigging weighing more than ten pounds. All mountings and attachments must be approved and stamped by an engineer licensed in Florida prior to submittal and the beginning of the installation.
- 2. Materials and Equipment submittal package:
 - a. A complete list of all materials and equipment to be furnished
 - b. Catalog cuts for all materials equipment
 - c. These must contain full information on dimensions, construction, applications, etc. to permit proper evaluation.
 - d. Catalog cuts must be properly identified as to their intended use and any options or variations must be clearly marked.
 - e. The contractor is to confirm equipment availability at time of submittal. It is assumed that all equipment submitted on is and will be available
 - f. Color selection samples of devices for Architect's selection.
- 3. Test Equipment: The sound contractor will submit to the owner a list of test equipment to be used to test, equalize and demonstrate the final installation.
- 4. Schedule: Prior to the commencement of the installation work, the sound contractor shall submit for approval, to the owner, an outline of a proposed commencement and completion schedule and project requirements.
- C. Variations: Any deviation from what is specified here and or shown on the system drawings must be "starred" and noted in ¼" high letters on the shop drawings and highlighted in the submittal data.
- D. Approval of shop drawings and materials does not relieve the AV system sub-contractor of any responsibilities.
- E. Samples may be requested by the Architect and shall be furnished for inspection at the Architect's office, at the Contractor's sole expense.
- F. Submit in quantities as required by the Architect.
- G. Shop drawing and submittals shall be revised and resubmitted as required.
- H. Four months prior to system activation for contractor testing submit a complete written narrative describing all system DSP and control programming and functionality.
- I. Two month prior to system activation for contractor testing submit the initial DSP configuration file and screen shots of all control pages for all control systems.

3.03 COORDINATION WITH OTHER WORK

- A. The sound contractor shall specifically coordinate the placement and sizes of conduit relating to this work and shall specifically review and approve the conduit rough-in in time to advise all parties of needed changes, omissions, etc. The sound contractor shall report this successful

coordination in writing to the owner's representative. Failing this, the following will be enforced:

1. The sound contractor shall provide and install any additional conduits required for the hookup, proper location and proper isolation of the various cable / signal types and equipment in the systems. The sound contractor must coordinate his conduit installation with those installed by the electrical contractor. All conduits shall be sized to their intended fill plus fifty percent.
- B. The contractor shall at all times coordinate his work with the other trades to ensure smooth progress of work and satisfactory final results.

3.04 INSTALLATION:

- A. Comply will all recognized industry standards, professional practices and references.
- B. Personnel: A single, competent, technically qualified foreman will oversee the entire job from start to finish. This foreman must:
 1. Be present on the job site during all phases of installation and testing.
 2. Be authorized to receive instructions from the Architects or their representatives.
- C. Only experienced sound installers shall be employed on this job.
- D. The AV system sub-contractor shall keep the job adequately staffed at all times.
- E. All job documents pertaining to the installation of this system will be accessible to all workers throughout the installation process.
- F. Installation practices shall be in accordance with OSHA Safety and Health Standards and all local codes.
- G. The AV system sub-contractor shall not commence the installation of equipment and devices, other than the pulling of cable, until all areas are clean, painted and finished to a point that they are completely dust, dirt, lint, fiber and airborne particle free. The air conditioning system must be operating to its design level and be able to keep all areas with sound equipment stable.
- H. General Workmanship:
 1. The installation of all work shall be neat.
 2. All boxes, equipment, etc shall be plumb and square.
 3. The installation shall conform to the plans and spec.
 4. Equipment racks shall be assembled, wired and tested in the AV system sub-contractor shop prior to delivery to the job site.
- I. Wiring:
 1. If enclosed in conduit run only similar signal levels in a single conduit.
 2. All pulls to be made be hand, care will be taken not to nick cable jackets, and any nicked or damaged cable will be replaced.
 3. A pull string will be left in all conduits after wire is installed.
 4. NO SPLICES WHATSOEVER IN CONDUIT!
 5. If not enclosed in conduit neatly group cables into bundles and secure out of harms way.
 6. Separate cable grouping by signal level. Mic and A.C. power shall be not less that 18" all other levels by not less than 6".
 7. Include spare cables with all field runs. Quantity to be 10% or 1 which ever is greater unless otherwise specified.
 8. All category type cabling must be certified

J. Terminations:

1. All cables shall be permanently labeled at every termination.
2. Service loops of not less than 6" will be present at all terminations to equipment.
3. Where terminal blocks or barrier strips are used only uninsulated fork terminals with a brazed seam, sized according to wire and stud sizes, crimped with notch across from the seam will be approved.
4. Use barrier strips on equipment where provided.
5. Where shielded cable is in use leave shield drain wire the same length as the circuit conductor(s), sleeve shield drain wire in green pvc tubing. Cap where the cable jacket was removed with heat shrink. Where the shield drain wire is to be lifted follow the above and fold back over cable jacket. Then cap end with heatshrink. Do not use a single piece of heatshrink for this use two smaller ones.
6. All soldering will be clean and neat and not exhibit evidence of a " cold" joint, where necessary heat sinks will be used. Use only rosin core "electronic type " solder.
7. Wire nuts will be allowed only for field connections of 70 volt speaker lines and priority attenuation control lines, and then only when the proper size is used.

K. Polarity:

1. The " high " side will be connected to pin 2 on XLR connectors, to tip on 1/4" connectors and to the pin on phono connectors.
2. The " low " side will be connected to pin 3 on XLR connectors, to ring on 1/4" balanced connectors and to case on phono connectors.
3. Microphones will be wired so that an acoustic compression at the diaphragm produces a positive going signal on pin 2 with respect to pin 3.
4. Speakers will be wired so that when a positive going signal is applied to the + or red terminal an acoustic compression is produced.
5. The system will be wired to maintain absolute polarity though all system components to insure that a positive signal on pin 2 or tip produces a positive signal at the + or red speaker terminal.

L. Shield Grounding:

1. Do not tie pin 1 to case of XLR connectors anywhere.
2. Microphone shield drain wires will be grounded only at mixer inputs. Where microphone lines and mixer inputs run through a patchbay, connect shield drain wire to sleeve of patchbay connector and only to this point.
3. Line level lines will have shield drain wire connected to ground at outputs and lifted from ground at inputs.
4. The intent here is to not make ground loops, should any situation arise which would form a ground loop, please inform the owner for direction.

M. Mountings and Attachments:

1. Any and all structural, mounting, or rigging details are shown on the drawings for concept only.
2. The detail drawings and calculations of all proposed mounting or rigging of any equipment weighing more than ten pounds will be approved and stamped by a P.E. who is licensed in the same State as the installation.
3. Each cluster element is to be individually adjustable.
4. Provide for an adjustment range of +/- 10 degrees from the information shown in the contract documents.

5. In the absence of specific direction otherwise, standard rigging practices shall be followed.
- N. Labels:
1. Cable Labels: All cables shall be labeled at all termination points. The label shall not be hand written. Clear heat shrink shall cover the label.
 2. Equipment Labels. All equipment shall be labeled front and rear. Labels shall functionally describe the use of each piece of equipment. On equipment having multiple channels, each channel shall be labeled. Additionally the equipment label will call out equipment designation which will correspond with the designations shown on the approved AV system sub-contractor one-line diagram. Labels shall be engraved lanacoid, white letters on black background, with a minimum letter size of 3/16". Approved patchbay labeling may vary from this.
- O. Power Sequencing. The system shall turn on and off, in proper order, on circuit at a time, when the power switch is pressed. The power light shall be solid on when all circuits are on, and shall flash during sequencing.
- P. The system may not be used prior to checkout.

3.05 INSPECTION AND TESTING:

- A. During the installation of the equipment the AV system sub-contractor shall arrange for access as necessary for inspection of equipment by the owner's and/or architect's representatives.
- B. Provide a safe means of accessing all system components for all visits.
- C. Equipment Pretesting:
 1. All racks are to be built and wired in AV system sub-contractor shop and tested prior to delivery to site.
 2. All other equipment is to be tested prior to delivery and installation.
 3. All site wiring and terminations must be tested and documented.
 4. A written test report will be submitted to the owner prior to final inspection that will include at a minimum:
 - a. Transfer function measurements showing frequency response, phase response and either coherence or signal / noise ratio for each speaker.
 - b. A composite chart which overlays all similar speaker model plots onto a single chart where the magnitude of the frequency response has been normalized across all included speakers.
 - c. Cable certifier printouts of all network / CAT type cable links.
 - d. TDR plots of all coax type cabling.
 - e. Cable tester reports for open / shorts / crossover / connections to ground of all mic jack, line jack, monitor speaker and tie line cabling.
 - f. Speaker Z plots for all installed speakers /speaker lines. 70V systems need not be separated, all other speaker lines must be measured one speaker at a time.
 - g. A composite cart which overlays all similar speaker Z plots onto a single chart.
 - h. Screen shots of Dante controller showing all routing, addressing, status and performance parameters.
 - i. DM Tools – DM frame test report
 - j. Photo showing projection screens deployed and projected test images
 - k. Switch status reports
- D. Final Inspection:

1. The final inspection will confirm that the systems, as installed, meets the requirements of this spec, the contract documents, and the approved AV system sub-contractor shop drawing and submittals.
2. The Theatre Consultant or his representative will conduct all final system tests and equalization adjustments in order to determine final acceptance.
3. In no event shall the theatrical audio and video systems installation be submitted for final approval or acceptance until any and all elements of the facility that may have a bearing on the system performance, including but not limited to doors, windows, HVAC, carpeting, furniture, wall coverings, interior design elements, lighting and lighting control systems have been completed and are operable. All elements that may effect audio and video systems operation or performance shall be "on" and operating during adjustments. The AV contractor will be responsible for coordinating the requirements of this paragraph with other work on the project.
4. The AV system sub-contractor will inform the owner in writing of the system's completion. The AV system sub-contractor will then request final inspection by the consultant, and carry out the necessary coordination. This coordination includes:
 - a. Giving at least fourteen days notice to the consultant prior to the final inspection.
 - b. Arranging for the AV system sub-contractor and consultant's exclusive use of the space.
 - c. Arranging for a HVAC technician to be available to turn the AC system on and off as required.
 - d. Arranging for a lighting technician to be available to control the stage lighting as required.
 - e. The AV system sub-contractor job foreman and one additional worker familiar with the job will be present during all check out, testing and tuning.
5. AV system sub-contractor will complete the following tasks prior to consultant's arrival:
 - a. Unpack and assemble all portable equipment.
 - b. Place all portable equipment in one location.
 - c. If anything has been turned over to the owner have the signed Letters of Transmittal on site.
 - d. Complete all required paperwork (pre-testing reports, letters indicating successful coordination of the installation, etc.).
 - e. Remove all security covers.
 - f. Unlock all doors.
6. AV system sub-contractor will provide all necessary software, cables, and interfaces to facilitate the setting of computer, remote controlled, or DSP based equipment.
7. AV system sub-contractor will either: 1) relocate all system equalizers to a tech area in the house for the duration of system tuning or 2) for remotely controllable devices, locate the control position in a tech area in the house for the duration of system testing. In either case a tech area in the house will be required with a minimum of a 4' x 6' folding table, intercom communications to the rack and console locations, and AC power.
8. AV system sub-contractor will provide the following test equipment for use during tuning and acceptance testing:
 - a. Sennheiser ZP-3 impedance bridge.
 - b. Low distortion sine wave oscillator with variable sweep (start frequency, stop frequency, and sweep rate).

- c. Distortion meter.
 - d. Oscilloscope dual channel, 100Mhz, .001v/div vertical amp.
 - e. Noise generator that will provide pink, white, or bandwidth limited pink noise.
 - f. Portable 1/3 octave real time audio spectrum analyzer.
 - g. Precision sound level meter with filter set.
 - h. Polarity checker.
 - i. Precision true R.M.S. reading A.C. millivolt meter with dB scale.
 - j. Meyer Sound SIM 3 complete with all necessary accessories and at least 3 matching measurement microphones.
 - k. Playback and recording media for testing all supplied source equipment.
- 9. AV system sub-contractor will provide safe means to access all system components during the entire commissioning process.
 - 10. AV system sub-contractor shall provide personal and equipment to make adjustments to the speaker cluster(s), as well as to correct problems, for the entire inspection and testing period.
- E. Should more than two trips be required to complete the systems testing, systems tuning, and clearing punch list items, the AV system sub-contractor will be charged for any additional visits. These charges will include:
- a. A minimum of two people at a rate of \$1520 per day per person.
 - b. Travel expense to and from the job site.
 - c. These charges will be paid to the consultant, in advance of the consultant's arrival on the job site.

3.06 MANUALS:

- A. Prepare four identical copies of owner's manuals. The owner is to receive two, the consultant receives one and the AV system sub-contractor retains one. Before distribution of manuals submit one copy to consultant for approval. Each manual is to contain the following:
 - 1. System one line drawing including all labeling and changes (" as built ").
 - 2. Owner's manual for each piece of equipment.
 - 3. Schematic diagram for each piece of equipment.
 - 4. Contractors service phone number in a conspicuous place.
 - 5. All test reports.
 - 6. Electronic (PDF) copy of the manual (indexed with TOC and links to sections)
 - 7. Electronic (USB flash drives) loaded with the PDF manual and all software, drivers and configuration files.

3.07 INSTRUCTION: THE FOLLOWING IS TO BE CARRIED OUT WITHIN TWO MONTHS OF SYSTEM ACCEPTANCE:

- A. Provide a total of 16 hours of instruction, spread over four training sessions. This is to be time on site, travel time is not to be included within the allotted time.
- B. Provide operational assistance for the first usage of the system. This is to be on the owners time schedule but, not to exceed 8 hours.

3.08 WARRANTY

- A. AV system sub-contractor will warrant the system to be free from defects in materials and workmanship for a period of one year from the date of acceptance, or first beneficial use, which ever comes first.

- B. Acts of god and owner abuse, or neglect are not covered.
- C. During the warranty period the AV system sub-contractor will respond to and correct any call for service within one day of the call. Loaner equipment will be provided if necessary

END OF SECTION

**SECTION 27 5116
PUBLIC ADDRESS SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Speakers.
- B. Clock/Speaker Enclosures.
- C. Sound system cable.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0533.16 - Boxes for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.

1.04 SYSTEM DESCRIPTION

- A. Public address system for voice and music.
- B. Output components:
 - 1. Speakers.
 - 2. Surface and Recessed combination clock/speaker baffles.
 - 3. Provide new clock speaker baffles at all new clock/speaker locations shown on the drawings, If combo units not shown provide single box for clock or speaker.
- C. All low voltage wiring not in conduit shall be Plenum Rated.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements. Indicate layout of equipment mounted in racks and cabinets, component interconnecting wiring, and wiring diagrams of field wiring to speakers and remote input devices.
- C. Product Data: Provide data showing electrical characteristics and connection requirements for each component.
- D. Test Reports: Indicate satisfactory completion of each test recommended by the manufacturer.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Operation Data: Include instructions for adjusting, operating, and extending the system.
- G. Maintenance Data: Include repair procedures and spare parts documentation.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70 and Federal Communications Commission.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.
- C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- D. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles of Project.
- E. Products: Listed, classified, and labeled as suitable for the purpose intended.

- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bogen Communications, Inc: www.bogen.com/#sle.
- B. Toa Electronics, Inc: www.toaelectronics.com/#sle.
- C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 COMPONENTS

- A. Speakers: 8 inch coaxial speaker with integral crossover circuit.
 - 1. Power Rating: 20 watts.
 - 2. Frequency Range: 45 to 18,000 Hz.
 - 3. Sound Pressure Level: 95 dB at 3 feet with 1 watt input.
 - 4. Magnet: Ceramic; 10 ounces low frequency unit; 3 ounces high frequency unit.
 - 5. Dispersion: Minus 3 dB at 90 degrees, minus 5 dB at 110 degrees.
- B. Speaker Baffles and Enclosure: Square, painted steel, with uniform perforations.
 - 1. Size: 12 inch.
 - 2. Finish: White.
 - 3. Speaker Backbox: Insulated with sound-deadening material.
- C. Volume Pads: Transformer type rated 10 watts.

2.03 WIRE AND CABLE

- A. Plenum Cable for Speaker Circuits: 22 AWG copper conductor, 300 volt insulation, rated 200 degrees C, paired conductors twisted together shielded and covered with a nonmetallic jacket; suitable for use for Class 2 circuits in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Splice cable only in accessible junction boxes or at terminal block units.
- C. Make cable shields continuous at splices and connect speaker circuit shield to equipment ground only at amplifier.
- D. Install input circuits in separate cables and raceways from output circuits.
- E. Provide protection for exposed cables where subject to damage.
- F. Use armored cable for outside speaker circuits.
- G. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure for ceiling suspension system. Include bridle rings or drive rings.
- H. Use suitable cable fittings and connectors.
- I. Connect reproducers to amplifier with matching transformers.
- J. Ground and bond equipment and circuits in accordance with Section 26 0526.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide the services of manufacturer's technical representative to prepare and start system.
 - 1. Include making of final wiring connections, inspection and adjusting of completed installation, and systems demonstration.
 - 2. Certify that installation is complete and performs according to specified requirements.
- C. Measure and record sound power levels at designated locations.

3.03 ADJUSTING

- A. Adjust transformer taps for appropriate sound level.
- B. Adjust devices and wall plates to be flush and level.

3.04 CLOSEOUT ACTIVITIES

- A. See Section 01 7900 - Demonstration and Training, for additional requirements.
- B. 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.

3.05 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of public address and music system for one year from Date of Substantial Completion.

END OF SECTION

SECTION 27 5313
GPS (PRIMEX) WIRELESS CLOCK SYSTEM

PART 1 GENERAL

1.01 GENERAL

- A. Middle/High School:
 - 1. Provide additions and modifications to the existing system as indicated on plans.

1.02 SECTION INCLUDES

- A. Clocks
 - 1. Analog (Lithium battery powered)

1.03 RELATED SECTIONS

- A. Division 26 – Electrical (120 volt grounded outlet required for transmitter.)

1.04 REFERENCES

- A. This Technical Specification and Associated Drawings

1.05 SYSTEM DESCRIPTION

- A. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Savings Time.
- B. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- C. The system shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
- D. The system shall incorporate a “fail-safe” design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
- E. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

1.06 SUBMITTALS

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.
- B. Operating License: Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license must be delivered to the Owner/End User.
- C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.
- D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.
- E. Floor plans indicating the location of system transmitter(s), approved by manufacturer, will be submitted to owner prior to installation.

1.07 QUALITY ASSURANCE

- A. Permits: Obtain operating license for the transmitter from the FCC.
- B. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing commercial time system products including 4 years experience producing GPS wireless time systems.
 - 2. Installer: Company with documented experience in the installation of commercial time systems.
- C. Prior to installation, a site survey must be performed to determine proper transmitter placement.

1.08 DELIVERY STORAGE AND HANDLING

- A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
- B. Store equipment in finished building, unopened containers until ready for installation.

1.09 PROJECT SITE CONDITIONS

- A. Clocks shall not be installed until painting and other finish work in each room is complete.
- B. Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.10 SYSTEM STARTUP

- A. At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all clocks are functioning.

1.11 WARRANTY

- A. Manufacturer will provide a 5 year warranty on GPS receiver and transmitter. All other components will have a 1 year warranty.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. GPS wireless clocks: Pyramid Wall Clock: Radio Freq, Arabic, Round, 13 1/4 in Overall Dia., 13 in Face Dia., Battery, Analog
- B. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- C. Other systems requiring wiring and/or conduit between master and clocks will not be accepted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
- B. Verify that 120 volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.

3.02 INSTALLATION

- A. Analog clocks (Lithium battery): Perform the following operations with each clock:
 - 1. Install batteries.
 - 2. Set clock to correct time in accordance with manufacturer's instructions.
 - 3. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.
 - 4. Install the analog clock on the wall in the indicated location, plumb, level and tight against the wall. use suitable fasteners as approved by clock manufacturer.
- B. Wire guards: Secure to wall, using approved theft-resistant fasteners.

3.03 ADJUSTING

- A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.04 CLEANING

- A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.05 DEMONSTRATION

- A. Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.

3.06 PROTECTION

- A. Protect finished installation until final acceptance of the project.

3.07 TESTING

- A. All devices must be tested at their operational location under normal operational conditions to assure reception of signal.

END OF SECTION

**SECTION 28 4600.01
FIRE DETECTION AND ALARM SYSTEM**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. All fire alarm devices, circuitry, and controls are to be furnished and installed by Electrical Contractor.
 2. Electrical Work Contractor is responsible for recessed back boxes and raceway to above ceilings for fire alarm appliances where indicated in new wall construction.
 3. Electrical Work Contractor is responsible for removing and disposing of abandoned fire alarm appliances, detectors, circuitry, and associated components in their entirety.

1.02 THE FIRE ALARM EQUIPMENT AND INSTALLATION SHALL COMPLY WITH THE CURRENT PROVISIONS OF THE FOLLOWING STANDARDS AND SHALL BE LISTED FOR ITS INTENDED PURPOSE AND BE COMPATIBILITY LISTED TO ENSURE INTEGRITY OF THE COMPLETE SYSTEM:

- A. New York State Uniform Fire Prevention & Building Code
- B. National Fire Protection Association Standards:
1. NFPA 70 - National Electrical Code
 2. NFPA 72 - National Fire Alarm Code
 3. NFPA 90A - Installation of Air Conditioning and Ventilating Systems
 4. NFPA 101 – Life Safety Code
 5. NFPA 720 - Standard for the Installation of CO Detection
 6. U.S. Department of Justice - American Disabilities Act
- C. Provide system and components listed by Underwriters Laboratories Inc. (UL) for use in fire protective signaling system under following standards as applicable:
1. UL 864 - UOJZ, APOU Control Units for Fire Protective Signaling Systems.
 2. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
 3. UL 268A - Smoke Detectors for Duct Applications.
 4. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
 5. UL 228 - Door Holders for Fire Protective Signaling Systems.
 6. UL 464 - Audible Signaling Appliances.
 7. UL 1971 - Visual Signaling Appliances.
 8. UL 38 - Manually Activated Signaling Boxes.
 9. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
 10. UL 1481 - Power Supplies for Fire Protective Signaling Systems.

1.03 SYSTEM DESCRIPTION

- A. Design Requirements
1. Provide complete non-proprietary open source, analog addressable, digital multi-processor based fire alarm control system, including (but not limited to) all control equipment, power supplies (primary and secondary), initiating devices, synchronized audible and visual notification appliances, conduit, wiring, fittings and all other accessories necessary to provide complete and operable system.
 - a. Provide all components necessary to connect and operate all building fire protection system interfaces including (but not limited to):
 - 1) Carbon monoxide alarms.
 - 2) Fan shutdown operations.
 - 3) Automatic door release.
 - b. Sequence of Operation: Operation of manual station or automatic activation of any initiation device activates following system responses:
 - 1) Automatic shutdown of all air moving equipment throughout building.

- 2) Indication of alarm location on main fire alarm panel LCD display, and remote LCD display(s). (NOTE: EC shall coordinate system addresses with Owner prior to final programming to assure correct room numbering. Room numbering shall match door numbers upon completion of project.)
- 3) Notification of alarm to central station monitoring agency.
- 4) Activation of all fire protection system interfaces specified in this Section or indicated on Drawings.

B. Performance Requirements

1. Fire Alarm System: Non-proprietary, individually multiplex data address indicating building zone and room number for each manual pull station, smoke detector, heat detector, duct smoke detector, addressable monitor module and addressable control module with fire alarm control panel capable of supporting up to system total of 99 individual addressable devices and 99 addressable analog modules.
2. Fire Alarm Control System: Provides Class B, Style E (NFPA-72) analog addressable data communications circuits to provide connection of, and communication with, addressable devices.
 - a. Each addressable data communications circuit provides capability of communicating with up to 99 addressable devices.
 - b. Each circuit; connect to maximum 70 percent capacity to permit future additional addressable devices and capable of communicating with addressable device up to 2,500 ft. distant.
 - c. Circuits support 100 percent of addressable devices in alarm or operated at same time during both primary and secondary power supply conditions.
3. Addressable Monitor Modules - Provides individually-addressed alarm-initiating, supervisory or status monitoring circuits complying with requirements for minimum of 1 Class A, Style E (NFPA-72) supervised circuit for following non-addressable devices (NOTE: EC shall coordinate system addresses with Owner prior to final programming to assure correct room numbering.)
4. Addressable Control Modules: Provided with relays with at least 1 SPDT control contact to provide fire alarm system control of following remote equipment (NOTE: EC shall coordinate system addresses with Owner prior to final programming to assure correct room numbering):
 - a. Air Moving Equipment: Provide 1 shutdown contact for each air-moving unit.
 - b. Kitchen Gas Valve: Provide 1 shutoff contact for each kitchen gas valve.
 - c. Science Room Gas Valve: Provide 1 shutoff contact for each Science Room gas valve.
5. Fire Alarm Control System:
 - a. Provide each of following types of alarm sounding, indicating or communicating devices with Class B, Style Y (NFPA-72) supervised, alarm indicating appliance and/or communicating circuits:
 - 1) Horn Indicating Appliance: Provide minimum 1 circuit for each floor, with no more than 20 horns connected to each circuit.
 - 2) Alarm Strobe Indicating Appliance: Provide minimum of 1 strobe light circuit for each floor, with no more than 20 strobe lights to each circuit.
 - b. Provides relays for connection to and control of associated equipment, as follows:
 - 1) Central Station Agency Connections: Provide 3 SPDT contacts (system alarm condition, system supervisory off-normal condition, and system trouble condition) for connection to central station agency transmitter.
 - 2) Provide minimum 1 circuit for each floor, control contact for magnetic door holders.
6. Additional fire alarm devices (not indicated on drawings):
 - a. Include in bid price material and labor to wire two (4) 3 phase air handling units providing relays interfaced to existing motor starters for fire alarm fan shut down, assume wiring lengths of 350' from motor to FACP.
 - b. Include in bid price material and labor to install two (4) new duct smoke detectors in existing air handling equipment and wire said detectors assuming wiring lengths of 350' from each detector to FACP. Include associated remote-test-switch.
 - c. Include in bid price material and labor to install two (2) new heat detectors in existing storage spaces and wire said detectors assuming wiring lengths of 350' from detector to FACP.

1.04 SUBMITTALS

- A. Comply with requirements of SECTION 01 3000 – Administrative Requirements (and as modified below);
 - 1. Submit all submittal documentation specified in this Section no later than 30 calendar days after Award of Contract.
 - 2. Obtain Architect's acceptance of submittals in accordance with General and Supplementary Conditions and SECTION 01 3000 before ordering any components or equipment in proposed fire alarm system.
- B. Product Data: Submit manufacturer's documentation for all components of proposed fire alarm system required to demonstrate compliance with specified requirements, including (but not limited to) type, size rating, style, catalog number, manufacturer name, photograph, and catalog data sheet for each component.
- C. Shop Drawings: Submit following diagrams in both hard copy as well as computer disk format with supporting software to display diagrams on standard PC compatible computer.
 - 1. Submit complete one-line riser diagrams showing all equipment locations and sizes, and point-by-point wiring diagram with type and number of all conductors. Indicate device identification on one-line diagram.
 - 2. Submit detailed drawing of Fire Control Panel(s) including all module/component locations and panel point-to-point wiring diagrams including all field circuit termination points. (NOTE: Installer shall coordinate system addresses with Owner prior to final programming to assure correct building zone and room numbering.)
 - 3. Submit floor plan layout of Graphic Display Panel indicating building zones, room numbers, and "You Are Here" location.
- D. Quality Control Submittals
 - 1. Design Data
 - a. Submit calculations indicating size of standby batteries submitted for each panel and or power supply to provide minimum of 24 hours of standby power with additional 15 minutes of alarm at the end of the 24 hour period.
 - b. Submit calculations for signal circuit and power supply loading indicating amount of devices per circuit, alarm current per circuit, and alarm current per power supply output.
 - c. Submit complete list of all system points to be monitored and controlled as related to individual fire alarm control panel's initiating, signaling and control circuits.
 - 2. Contract Closeout Submittals: Comply with requirements of SECTION 01700, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.
 - a. Deliver 2 copies of following documentation to Architect within 15 days after date of system acceptance:
 - 1) Installation and programming manuals covering installed systems.
 - 2) Point-to-point diagrams of entire systems as installed including number of all conductors with indications of all terminations and splices. Diagram shall include system address and locations of all devices. (NOTE: Installer shall coordinate system addresses with Owner prior to final programming to assure correct building zone and room numbering.)
 - 3) Complete control panel generated and printed system sensitivity report showing all sensors with their address, associated sensitivity levels, current obscuration values, number of times device alarm verification has occurred, and current at time of acceptance.
 - 4) Full acceptance test report of inspection as provided to Architect and Fire Subcode Official as specified in "Acceptance Testing" in Field Quality Control in Part 3 below.

1.05 SEQUENCING AND SCHEDULING

- A. Do not interrupt existing fire alarm system while building is occupied. Coordinate and schedule all system interruptions with Owner's authorized representatives.

1.06 WARRANTY

- A. The Contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of two year from date of final acceptance by Owner or Architect. If any defects in materials or workmanship or operational failure under normal usage are experienced within warranty period, promptly correct at no expense to Owner.

1.07 MAINTENANCE

- A. Maintenance Service: Provide complete maintenance service for entire system for 1 year after final acceptance of system.
- B. The contractor shall make available to the Owner a maintenance contract proposal to provide a minimum of two inspections and tests per year in compliance with NFPA-72 guidelines.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Existing Fire Alarm System: Simplex

2.02 COMPONENTS

- A. System Circuitry:
 - 1. The Signaling Line Circuit (SLC) and Data Communication Bus (SBUS) shall be wired with standard NEC 760 compliant wiring. No twisted, shielded or mid capacitance wiring is required for standard installations. All FACP screw terminals shall be able to accept 14-18 AWG wire. All system wiring shall be in accordance with the requirements of NFPA 70, the National Electrical Code (NEC), and also comply with article 760 of the NEC.
 - a. Each SLC shall be capable of a wiring distance of 10,000 feet from the SLC driver module and be able to support 99 devices and 99detectors. The communication protocol to SLC devices must be digital. Any SLC loop device, which goes into alarm, must interrupt the polling cycle for priority response from the FACP. The FACP must respond consistently to a device that goes into alarm on an SLC in under 3 seconds. The SLC shall be capable of functioning in a class A or class B configuration.
 - 2. SLC loop Devices: Devices supported must include photoelectric smoke detectors, heat detectors, combination fire and CO detectors, contact monitoring modules and relay output modules. There is to be no limit to the number of any particular device type, up to the maximum of 99 detectors and 99 modules that can be connected to the SLC.
- B. Detectors
 - 1. Combination Fixed Temperature/Rate-of-Rise Heat Detectors: Addressable combination fixed temperature/rate-of-rise heat detector including thermistor heat sensor and operating at fixed temperature and predetermined temperature rise.
 - a. Continually monitors temperature of air in surroundings to minimize thermal lag to time required to process alarm.
 - b. Integral microprocessor determines if alarm condition exists and initiates alarm based on analysis of data.
 - c. Addressable heat detector has nominal fixed temperature rating of 135 deg. F (57 deg. C) and rate of rise rating of 15 deg. F (9 deg. C)/minute.
 - 2. Fixed Temperature Heat Detectors: Non-addressable 200 degree fixed temperature heat detector provided in all areas where rapid rise in temperature may be expected as normal operating conditions.
 - a. Detectors operate when temperature of center disk rises to rated temperature and element activates.
 - b. Detector is non-restorable and when activated, must be replaced.
 - c. Where non-addressable detector is used, provide addressable monitor module as specified.
 - 3. Smoke Detectors: Addressable photoelectric type with sensor having software defined sensitivity of 0.5 percent/ft to 3.0 percent/ft. and signal-to-noise ratio of 2.0 nominal.
 - a. Visual indication of alarm provided by latching LED on detector that periodically pulses to indicate power is being supplied to detector.

- b. LED feature user-defined.
- c. Visible alarm signal capable of being remotely annunciated.
- 4. Carbon Monoxide Detection:
 - a. Provide non-addressable CO detection device and equip with an addressable monitor module that shall supervise the onboard contact closure.
 - b. CO detector shall be UL 2075 listed.
 - c. Suitable for wall and/or ceiling mounting.
 - d. Shall be equipped with End of Life Alerting.
 - e. FACP Programming:
 - 1) Program FACP to annunciate a supervisory condition when CO has been detected.
 - 2) Equipment shall also be self-sounding and shall utilize the Temporal 4 signal style.
- 5. Duct Smoke Detectors: Equipped with addressable solid state ionization smoke detector heads capable of detecting visible and invisible products of combustion, capable of operating with variations in duct air velocity between 400 and 4000 fpm, and listed by Underwriters Laboratories, Inc. under current standards for duct smoke detectors to allow remote functional testing without generating smoke.
 - a. Enclosed in housing suitable for mounting to air duct, with sampling tube extending into air stream.
 - b. Each unit provided with remote mounted key operated Alarm Indicator/Test Switch.
- C. Manual Pull Station: Addressable, non-coded double action type, requiring outer door to be lifted to expose actuator door. Upon pulling forward actuator door, unit locks into readily observable "alarm" position.
 - 1. Manual station constructed of aluminum.
 - 2. Each manual station requires key to reset actuated station; key same as key opening Fire Alarm Control Panel.
- D. Visual Alarm Signaling Appliances: Provide synchronized strobe light units in wall mount configuration, UL listed for fire protection service and producing field selectable 30, 75, 100 candela (CD) in accordance with ADA and 15 candela in accordance with UL 1971 and providing minimum flash rate of 0.33 HZ and 3 HZ maximum.
 - 1. Provides 0.2 seconds pulse duration with maximum duty cycle of 40 percent and time interval between initial and final points of 10 percent of maximum signal.
 - 2. All strobes shall be synchronized and conform to applicable provisions of Americans with Disabilities Act (ADA), UL standard 1971, NFPA 72, and ANSI A117.1 for light intensity and distribution and integrated with fire alarm system.
 - 3. Provide layout, design and candela ratings for common areas complying with provisions of NFPA-72-2002.
- E. Supplementary Relay Controls
 - 1. Fire alarm control unit incorporate necessary alarm activated relays as pilot control for fan shutdown, door release, etc., as specified.
 - 2. Shutdown of designated HVAC units through auxiliary contacts of fire alarm control panel after alarm condition initiated from any initiating device as shown on Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. The Electrical Work Contractor is to furnish and install wall mount backboxes at locations as indicated by owner. All notification appliances and detection peripherals are to be by the Owner. Contractor shall thoroughly coordinate installations with Owner on a daily basis.
- B. Upon testing and certification of new system by Owner, the Electrical Work Contractor shall remove and dispose of all abandoned fire alarm devices, circuitry, and associated components.

3.02 INSTALLATION

- A. Install fire alarm system in accordance with applicable provisions of NEC, NFPA-70, Article 760 - Fire Protective Signaling Systems.

1. Contractor performing fire alarm system work shall have NYCET certification or shall be a licensed fire alarm contractor. Contractor shall provide Fire Alarm Certification at time of permit application.
 2. Where existing fire alarm systems are being replaced, Contractor performing fire alarm system work shall comply with the requirements of the local Fire Marshall concerning the fire alarm system shutdown plans, procedures, and fire watch plans that will be implemented for system interruptions during construction. All existing fire alarm devices shall remain active until new cabling and devices are installed. Temporary interruptions are allowed while work is being done on the system. Work shall be coordinated so that system is fully functional at the end of the workday. If system is not fully functional at end of workday, Contractor shall provide personnel for fire watch as required by local Fire Marshall. and shall be responsible for all associated costs.
 3. Provide all labor, materials, equipment and services to perform all operations required for complete installation of fire alarm system and related construction as shown on Drawings and specified in this Section.
 4. Completely check, program and adjust all new and existing equipment on each system.
 5. Label each addressable device with label indicating device's unique address. Label shall comply with Specification Section 26 0553. Labels shall be installed so that they are visible without removing device from mounting base.
- B. Wiring
1. All fire alarm cable shall be (initiating and notification circuit wiring), shall be Type FPLP plenum rated, sized in accordance with manufacturer's recommendations, regardless of environmental conditions.
 2. All FA cable located above accessible ceilings shall be bundled and tie-wrapped at 5 foot intervals and hung in saddle rings or J-hooks, supported to structure at 5 foot intervals. Cable shall not be considered properly supported by laying over top of conduits, piping, or building supports or bracing, approved saddle rings or J-hooks must be used.
 3. For wall mounted devices in finished spaces, or existing construction, where wiring cannot be concealed; all wiring shall be installed in surface metallic raceway, from device location to accessible ceiling space.
 4. Install all wiring in approved red finish EMT conduit in the following locations:
 - a. Unfinished areas (above ceilings, accessible attics, accessible crawl spaces, accessible basements, mechanical rooms, electric rooms, etc...)
 - b. Exposed, open joist spaces (storage rooms, shops, upper gymnasiums, upper stage, etc...)
 - c. Where otherwise subject to damage.
- C. Install all devices on exterior of building in weatherproof enclosures supplied by device manufacturer.
- D. In existing construction, install all interior surface mounted devices on surface mounted back boxes supplied by device manufacturer. In new construction, install all devices flush or semi-flush mounted, unless otherwise authorized by Owner.
- E. Provide fan shut-down of all HVAC equipment having 1000CFM (or greater) air movement capacity. Locate relay within 36 inches of units power disconnect, ahead of all controls.
- F. Provide duct smoke detectors in the supply and return air ductwork of all HVAC systems having 2000 CFM (or greater) air movement capacity. Install the supply duct detector downstream of the air filters and ahead of any branch connections. Install the return duct detector between the air handling unit and any re-circulation or fresh air inlet connections. Provide fan shut-down relay on power home run circuits, ahead of all controls.
- G. Install all fire alarm pull stations at 48 inches AFF, to conform to ADA requirements.
1. In locations where new device is replacing existing, contractor shall coordinate removal/replacement to allow re-use of existing backbox/conduits if possible.
 2. In existing construction all devices shall be flush mounted with circuit wiring concealed within wall.
 3. In locations where building construction prohibits flush-mounted installations, provide surface raceway device similar to "The Relocator" by L.E.D. Products, Wilmington, North Carolina. At such locations obtain written authorization from Owner's representative or Architect prior to providing surface raceway device.

4. Provide vandal resistant lexan shield (LS) in all Gymnasiums and Industrial Technology Shops / labs or as otherwise directed.
- H. Locate audible/visible signaling devices in strict accordance with requirements of Americans with Disabilities Act (ADA).
1. In locations where new device is replacing existing, contractor shall coordinate removal/replacement so that existing backbox/conduits can be re-used.
 2. In existing construction all devices shall be flush mounted with circuit wiring concealed within wall.
 3. In locations where building construction prohibits flush-mounted installations, provide surface raceway. At such locations obtain written authorization from Owner's representative or Architect prior to providing surface raceway device.
 4. Where combination audible/visible units used, place strobe light lens 80 inches minimum and 96 inches maximum above floor level.
 5. In locations where ceiling height is less than 90 inches AFF, place strobe light lens 6 inches below ceiling.
- I. In areas where detection and notification devices may be subject to physical damage, devices shall have protective wire guards as manufactured by Safety Technology International (www.sti-usa.com). All guards shall be listed for the fire alarm system devices and appliances protected.
- J. Install Magnetic Hold-Opens in collaboration with Contractor responsible for door installations.
- K. Install remote-test-switch devices associated with duct smoke detection or beam detection devices at accessible locations, (while standing at floor level). Clearly identify associated duct detector location and HVAC unit monitored on switch.
- L. Surface mount detection devices / notification appliances on FA manufacturer provided red finished surface mount box. Generic surface raceway / surface mount boxes will not be permitted.
- M. Upon acceptance of new fire detection and alarm system, Contractor shall disconnect and remove abandoned system in it's entirety, inclusive of all circuitry, conduits, cabinets, and associated equipment.
- N. The Electrical Work Contracto shall provide 120V, 20 amp, 1 phase power supply circuitry to all ansullary control relays furnished and installed by Owner. Coordinate each location in field with Owner.
1. For bidding purposes, assume a total of ten (10) individual dedicated 120v, 20A circuits. Circuit back to next nearest available 120V power panel. Provide 20A1P breaker in available space within panel and connect. For bidding purposes, assume a maximum of 200 LF of 20A circuitry for each circuit.

3.03 QUALITY CONTROL

- A. All fire alarm system equipment shall be new, unused, UL listed for its intended purpose, and be fully compatible to assure the integrity of the complete system.
- B. Acceptance Testing:
1. Perform 100 percent inspection and testing of all system devices.
 - a. Provide complete panel real-time printout as documentation of device, date and time. Any acceptance test not accompanied by real-time printout requires retesting of entire system by Contractor, including both alarm activation tests and tests of supervisory circuit at each device.
 - b. Provide inspection complying with requirements of applicable NFPA standards.
 - c. Provide to Owner and Fire Subcode Official complete typed list of every initiation, signaling, control, supervisory and auxiliary device with specific information regarding system address of device, location of device, date tested, manufacturer's model number, serial number of all analog components, status of device and zone or point as related to system. Obtain from owner the owner's room names/numbers that are to be assigned to each device.
 - d. Complete NFPA 72 Record of Completion document.
 2. Provide complete set of battery test results for panels including:
 - a. Charger output voltage under normal conditions
 - b. Charger output current under normal conditions
 - c. Open battery voltage
 - d. Supply voltage and current under primary power failure

- e. Supply voltage and current under primary power failure and system alarm that has activated all of panel's audible, visual and control circuits.
 - f. Calculations using battery test data obtained to determine minimum battery capacity of 24 hours under normal conditions and 5-minute alarm condition.
3. Take voltage readings at end of line of each alarm signal circuit to insure minimum operational levels.
- a. If voltage drop exceeds maximum of 3.4 volts from power supply to end of line under full circuit load, rewire circuits with appropriately heavier gage wire as required to comply with specified requirements.

3.04 ADJUSTING / CLEANING

- A. Completely clean all smoke detectors, as instructed by authorized factory representative, when system is substantially complete and accepted by Owner.

END OF SECTION

**SECTION 312000
EARTH MOVING**

PART 1 GENERAL

1.01 SUMMARY AND RELATED REQUIREMENTS

- A. Drawings and general provision of Contract, including Division-01, General Requirements, apply to work of this section.
- B. Refer to other sections of the specification, drawings, and details to determine type and extent of work there if affecting the work of this section, whether or not such work is specifically mentioned in this section. It is the intent of this specification to include all labor and material required to complete this section whether or not it is clearly or explicitly shown.
- C. Section Includes:
 - 1. Excavating and filling for rough grading the Site.
 - 2. Preparing subgrades for slabs-on-grade, walks.
 - 3. Excavating and backfilling for structures.
 - 4. Drainage course for concrete slabs-on-grade.
 - 5. Subbase course for concrete walks.
 - 6. Subbase course and base course for asphalt paving.
 - 7. Subsurface drainage backfill for walls and trenches.
 - 8. Excavating and backfilling trenches for stormwater.
- D. Related Requirements:
 - 1. Section 024115 – Temporary Erosion and Sediment Control
 - 2. Section 024116 - Site Clearing
 - 3. Section 321150 – Hot Mixed Asphalt Paving

1.02 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving, concrete walks and crusher dust finished walks.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
- F. Fill: Soil materials used to raise existing grades.
- G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.
- H. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- J. Utilities: On-site underground pipes, conduits, ducts, and cables.

1.03 SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Geotextiles.
 - 2. Controlled low-strength material, including design mixture.
 - 3. Warning tapes.
- B. Samples for Verification: For the following products, in sizes indicated below:
 - 1. Geotextile: 12 by 12 inches
 - 2. Warning Tap: 12 inches long; of each color.

1.04 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify Dig Safe New York for area where Project is located before beginning earth-moving operations.
- C. Do not commence earth-moving operations until temporary silt fencing and erosion- and sedimentation control measures specified in Section 024115 – Temporary Erosion and Sediment Control and as indicated on the Drawings are in place.
- D. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around protected areas unless otherwise indicated.
- E. Do not direct vehicle or equipment exhaust towards protection zones.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
- D. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- E. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- F. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

- G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- H. Drainage Course: A narrowly graded mixture of crushed stone or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.
- I. Filter Material: A narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C33/C33M; fine aggregate.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.02 GEOTEXTILES

- A. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability:
 - a. Class 2; AASHTO M 288.
 - b. As follows:
 - 1) Grab Tensile Strength: 247 lbf; ASTM D4632.
 - 2) Sewn Seam Strength: 222 lbf; ASTM D4632.
 - 3) Tear Strength: 90 lbf; ASTM D4533.
 - 4) Puncture Strength: 90 lbf; ASTM D4833.
 - c. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
 - d. Permittivity: 0.02 per second, minimum; ASTM D4491.
 - e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

- A. Prevent surface water and groundwater from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.03 EXPLOSIVES

- A. Explosives:
 - 1. Do not use explosives.

3.04 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross-sectioned by Landscape Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
 - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

3.05 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross-sections, elevations, and subgrades.

3.06 SUBGRADE INSPECTION

- A. Notify Landscape Architect-Engineer when excavations have reached required subgrade.
- B. If Landscape Architect-Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons or other equipment acceptable to the Landscape Architect-Engineer to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Landscape Architect-Engineer, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Landscape Architect-Engineer, without additional compensation.

3.07 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Landscape Architect-Engineer.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Landscape Architect-Engineer.

3.08 STORAGE OF SOIL MATERIALS

- A. Stockpiles borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.09 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, damp proofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for Record Documents.
 3. Testing and inspecting underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.
 6. Removing temporary shoring, bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontals so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
1. Under grass and planted areas, use satisfactory soil material.
 2. Under walks and pavements, use satisfactory soil material.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:
1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
 4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross-sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
1. Turf or Unpaved Areas: Plus, or minus 1 inch.

2. Walks: Plus, or minus 1 inch.
3. Pavements: Plus, or minus 1/2 inch.

3.14 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.
- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.
 2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.15 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course under pavements and walks as follows:
 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 2. Place base course material over subbase course under hot-mix asphalt pavement.
 3. Shape subbase course to required crown elevations and cross-slope grades.
 4. Place subbase course 6 inches or less in compacted thickness in a single layer.
 5. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 6. Compact subbase course at optimum moisture content to required grades, lines, cross-sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

3.16 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances were completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 1. Scarify or remove and replace soil material to depth as directed by Landscape Architect-Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

**SECTION 31 2316.13
TRENCHING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Trench, backfilling and compaction for electrical utilities and fuel oil piping.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete.
- B. Section 31 2200 - Grading: Site grading.
- C. Section 31 2316 - Excavation: Building and foundation excavating.
- D. Section 31 2323 - Fill: Backfilling at building and foundations.

1.03 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: 4 inches below finish grade elevations indicated on drawings, unless otherwise indicated.

1.04 REFERENCE STANDARDS

- A. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- B. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- C. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where indicated.
 - 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 FILL MATERIALS

- A. See Section 31 2323 - Fill and Backfill.

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 utilities that remain and protect from damage.
- C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

- D. Protect plants, lawns, rock outcroppings, and other features to remain.
- E. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Architect.

3.03 EXISTING FACILITIES

- A. General: The Drawings indicate existing subsurface facilities anticipated to be encountered during construction of the work, or located in such close proximity to the work to be done under the Contract as to require special precautions and methods for their protection. These facilities include sewers, drains, water mains, conduits and their appurtenances. However, all sizes, locations and heights or depths indicated are only approximately correct and the Contractor shall conduct his operations with caution and satisfy himself as to the accuracy of the information given. He shall not claim nor shall he be entitled to receive compensation for damages sustained by reason of the inaccuracy of the information given or by reason of his failure to properly maintain and support such structures.
 - 1. There may be other subsurface facilities, the existence and/or location of which are not known, such as individual water and gas services, electrical conduits, telephone, unknown storm drains, etc. The Contractor shall consult with the owners of these facilities and shall determine, prior to construction, the location and depth of any such facilities which may exist in the area to be excavated. The contractor shall follow all requirements of the Safe Dig protocols.
- B. Notification and Protection Procedures: Except where superseded by State or local regulations, or in the absence of any applicable regulations, the Contractor shall observe and comply with the following steps:
 - 1. Prior to excavating determine correct field locations of all nearby underground facilities or arrange for the owner thereof to locate same.
 - 2. Prior to excavating notify owners of nearby underground facilities when excavating is to take place, allowing them reasonable time to institute precautionary procedures or preventive measures which they deem necessary for protection of their facilities.
 - 3. Prior to excavating in cooperation with said Owners, provide temporary support and protection of those underground facilities which may be especially vulnerable to damage by virtue of their location or those which could create hazardous conditions in the area if damaged (i.e., gas mains, electrical cable, etc.).
- C. In the event of damage to any underground facility from the Contractor's operations, immediately notify the Owner thereof. No backfilling shall begin at such facility until repairs have been made by the Contractor.
- D. In case of an electrical short, or escape of gas or hazardous fluids (resulting from damage to an underground facility), immediately notify all persons who might be endangered and assist in their evacuation from the area.
- E. Support of Existing Facilities: Existing facilities encountered within an excavated area shall be adequately supported, blocked and/or braced in a manner approved by the Owner of the facility. Such supports shall be left in place, if required by Owner, and to the extent so required. Backfilling and compaction under and around the facilities shall be accomplished with extreme caution so as not to disturb or damage the facility or any supports thereof, and so as to prevent future settlement and possible rupture of the facilities.
- F. Relocation of Existing Facilities: Should the location or position of any gas or water pipe, public or private sewer or drain, conduit or other structure be such as, in the opinion of the Engineer, to require its removal, realignment or change, such alteration shall be without cost to the Contractor for the work of removal, realignment or change only; however, such structure shall be uncovered and supported or sustained by the Contractor at his own cost and expense, before such removal or before and after such realignment or change, as constituting part of his Contract. The Contractor shall not become entitled to claim any damages or extra compensation for or on account of the presence of such structures or on account of any delay due to removal or rearrangement of the same, but the Contractor shall be entitled to such an extension of time for the completion of the work as the Engineer shall determine if the work has been delayed by the removal, realignment or change of any such obstruction.

- G. Specific Protection of Water Mains: Where a minimum 10' horizontal separation or a minimum 18" vertical separation (bottom of water pipe to top of sewer pipe) cannot be maintained between a water main and sewer line, one or more of the following remedies shall be incorporated in the work as directed by the Engineer .
1. Encase pipe being installed in a watertight steel casing for 10'-0" each side of crossing.
 2. Sewer line to be AWWA Water Works Grade 150 psi pressure rated pipe, pressure tested to ensure water tightness.
 3. One full length of water main shall be centered over the sewer line, so that both joints will be as far from the sewer as possible.
 4. Relocate water main to obtain minimum vertical separation.
 5. The Contractor shall, prior to start of work, stake out or have staked out, all existing utilities that exist within his work area.
 6. Any water services damaged, temporarily relocated or repaired shall be reconstructed using HDPE piping up to and including 2" diameter. Above 2" diameter materials utilized shall be as determined by the Owner.

3.04 TRENCHING

- A. Topsoil Removal and Storage: All topsoil, loam, or other designated materials covering the areas to be excavated shall be removed and stockpiled, unless stated otherwise. Stockpiles shall be established only at approved locations, and they shall be properly maintained until reused.
- B. Pavement Cutting and Breaking:
1. Pavement covering those areas to be excavated shall be broken up, removed and then disposed of in accordance with applicable regulations.
 2. All paved areas shall be first cut or scored continuously along a straight line, parallel to and on each side of the centerline of the trench, at a width sufficient for the trench excavation.
 3. Pavement cuts in concrete pavement or pavement with a concrete base shall be made by scoring or cutting the concrete with a concrete saw.
 - a. The depth of the saw cut shall be a minimum of one-third the concrete pavement thickness.
 - b. The concrete pavement shall then be broken up with hand operated, pneumatic paving breakers, before excavation.
 - c. Drop hammers or "headache balls" will not be permitted for breaking up concrete pavement.
- C. Pavement cuts in blacktop pavement shall be made by scoring or cutting the pavement with a concrete saw, pneumatic paving breaker or drop-hammer-type pavement cutter.
1. The pavement cut must be continuous, and made for the full depth of the pavement.
- D. Excavation within paved areas and street pavement shall be preceded by cutting the pavement with power tools as described in these Specifications.
- E. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- F. Slope banks of excavations in accordance with OSHA requirements.
1. Where sloping of banks can not be accomplished due to onsite restrictions trench walls shall be shored and braced utilizing sheeting methods or other appropriate methods of trench wall stabilization.
 2. The Contractor shall maintain all trenches and excavations in a safe condition.
- G. Cut trenches as shown on drawings and/or wide enough to allow inspection of installed utilities.
- H. Trench excavations shall be carried to the lines and subgrades shown on the contract drawings, or directed by the Engineer.
1. The Contractor shall excavate all material encountered, and trench widths for pipes shall be held within the minimum and maximum limits shown on the contract drawings.
 2. Excavation shall be such that a flat bottom trench of allowable width is established at the required subgrade elevation for subsequent installation of pipe foundation material.

- I. When directed by the Engineer as a result of unsuitable soil conditions, trench excavation shall be carried below the required subgrade and a special pipe foundation installed in conformance with the Contract Documents.
 - 1. The Contractor will be paid for special pipe foundation, when directed by the Engineer, under the appropriate bid items. However, if special pipe foundation is required as a result of the Contractor's method of operation, no payment for special pipe foundation will be made. In any event, the Contractor's operations shall result in a stable base free from standing water, consistent with trench width requirements.
 - 2. The contractor shall provide appropriate means and methods to maintain trench width requirements.
- J. Trenches shall not be opened for more than 200' in advance of installed pipe, nor left unfilled for more than 100' in the rear thereof. Excavation of the trench shall be fully completed at least 20' in advance of pipe laying operations.
- K. Do not interfere with 45 degree bearing splay of existing foundations.
- L. Hand trim excavations. Remove loose matter.
- M. Rock shall be trimmed back on each side of the trench so that no rock protrudes within 6" of the installed pipe. Rock shall also be trimmed back across the bottom of the trench so that no rock protrudes within 6" of the installed pipe.
- N. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.
- O. Remove excavated material that is unsuitable for re-use from site.
- P. Remove excess excavated material from site.
- Q. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.
- R. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Engineer .

3.05 SURPLUS MATERIAL

- A. On-site disposal of surplus materials from excavation, if permitted, shall be directed by the Engineer.
 - 1. If required that surplus material be hauled from the site, the Contractor shall make all arrangement for disposal sites, unless the Owner has designated special locations.
 - 2. The Contractor shall carefully investigate all aspects of surplus material disposing operations. Pavement rubble, tree stumps, trash and debris shall be disposed of off-site.
 - 3. All expenses for disposal shall be borne by the Contractor.
- B. When it is necessary to haul soft or wet material over streets or pavements, the Contractor shall provide suitable watertight vehicles to prevent deposits on the streets or pavements.
 - 1. In all cases where any materials are dropped from the vehicles of the Contractor, he shall clean up the same as often as directed, and keep the crosswalks, street and pavements clean and free from debris.
- C. Prior to depositing surplus material at any off-site location, the Contractor shall obtain a written agreement between himself and the owner of the property on which the disposal of the material is proposed. The agreement shall state that the owner of the property gives permission for the Contractor to enter and deposit material of a particular classification on the owner's property at no expense to the project Owner, and shall include any other conditions pertinent to the situation as agreed upon by each party. A copy of said agreement shall be furnished to the Engineer.

3.06 MAINTENANCE OF EXCAVATIONS

- A. All excavations shall be properly maintained while they are open and exposed.
- B. Sufficient and suitable barricades, warning lights, flood lights, signs, etc., to protect life and property shall be installed and maintained at all times until the excavation has been backfilled and graded to a safe and satisfactory condition.

- C. The Contractor shall tightly enclose all open trenches and pits overnight and during non-work periods with snow fencing or similar type fencing, adequately supported so as to form a tight barricade.

3.07 REMOVAL OF WATER

- A. All trench excavations shall be maintained in a dry condition.
- B. The Contractor shall build all drains and do all ditching, pumping, bailing, and all other work necessary to keep the trench excavation clear of groundwater, sewage, or storm water during the progress of the work and until the finished work is completed to ensure that the work is safe from damage.
- C. Where suitable construction conditions cannot be obtained by other methods, the Contractor shall install and operate a wellpoint dewatering system to drain the site effectively.
 - 1. Wellpoint systems shall be sufficient in size to dewater excavations 2' below subgrade and shall be capable of maintaining the water table at such elevation until the work required to be constructed in the dry is completed, and until all structures are safe from flotation due to high groundwater.
 - 2. To this end the wellpoint system shall be operated continuously on a 24-hour day, 7-day week schedule. Wellpoint systems shall be designed and supervised by a reputable dewatering equipment supplier or contractor.
 - 3. The wellpoint system shall have standby pumping units which must be operated for at least 10 minutes each day.
 - 4. All water pumped or drained from the work shall be disposed of in a manner satisfactory to the Engineer.
 - 5. Necessary precautions shall be taken to protect all construction against flooding. Cost of wellpointing shall be included in the contractor's Base Bid Price.
 - 6. The Contractor's methods shall result in an excavated trench having a stable base free of any standing water. Cost of removal of water, irrespective of methods used, shall be including the Base Bid Price. No separate payment shall be made for this work

3.08 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with as outlined in Section 31 2323 or as indicated on the contract drawings..
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.09 BACKFILLING

- A. Backfilling shall be started as soon as utility and piping installation has been completed and concrete has acquired a suitable degree of strength, and proceed expeditiously thereafter. Backfill shall be started at the lowest section of the area to be backfilled. Natural drainage shall not be obstructed at any time.
- B. Backfill material shall be inspected prior to placement and all visible roots, vegetation, organic matter, or other foreign debris shall be removed. Stones shall not be placed in clusters which will create voids.
- C. Where excavated rock fragments are of such size that they cannot be used for backfilling, and/or Contractor elects to dispose of all excavated rock at off-site locations, and the quantity of on-site material is insufficient to complete the backfilling of the excavated area and/or Special Backfill has not been specified or directed by the Engineer, then the Contractor shall borrow suitable material and complete the backfilling requirements at no additional cost to the Owner.
- D. Backfill material shall not be placed when moisture content is too high to allow proper compaction. When material is too dry for adequate compaction, water shall be added to the extent necessary.
- E. No backfill material shall be placed on frozen ground nor shall the material itself be frozen when placed.
 - 1. No calcium chloride or other chemicals shall be added to prevent freezing.
- F. Material incorporated in the backfilling operation which is not in satisfactory condition shall be subject to rejection by the Engineer and removal at the Contractor's expense.
- G. Backfill to contours and elevations indicated using unfrozen materials.
- H. Fill up to subgrade elevations unless otherwise indicated.
- I. Employ a placement method that does not disturb or damage other work.

- J. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- K. Maintain optimum moisture content of fill materials to attain required compaction density.
- L. Pipe Bedding Material: Pipe foundations and pipe sidefills to a depth of 1' above the pipe shall be placed in 6" layers and thoroughly compacted by approved mechanical methods to insure firm bedding and side support. Pipe bedding material is specified in Section 31 2323. The entire surface of the pipe bedding material shall be compacted by approved mechanical means.
- M. Trench and Backfill: The remainder of the trench shall be backfilled and consolidated in accordance with one of the following procedures, depending on the location of the trench and adjacent land use.
 - 1. Procedure I: For pipelines through unimproved areas where subsequent settlement of the backfill above the pipe bedding material can be tolerated:
 - a. Backfill material shall be placed in layers not exceeding 12" thick in the trench and each layer compacted by mechanical means. The top layers shall be compacted mechanically and mounded to allow for subsequent settlement. Maintain trench surface until completion of contract and repair as necessary within guarantee period.
 - 2. Procedure II: For streets and paved areas where permanent pavement is not to be placed immediately after backfilling and for lawns and areas where minimum subsequent settlement of the backfill above the pipe bedding material is required:
 - a. Same as for Procedure I, except surface of backfill shall be compacted by mechanical means before placement of temporary paving or pavement subbase.
 - b. For lawn areas and similar locations, top of backfill shall be compacted by mechanical means and surface maintained prior to topsoil installation, fine grading, and seeding.
 - 3. Procedure III: For highways, streets, or pavement where permanent pavement is to be placed immediately or soon after completion of backfill:
 - a. Backfill material shall be placed in layers not exceeding 6" thick and each layer thoroughly compacted by mechanical means.
 - 4. The Contractor shall submit his proposed backfill compaction method plan for approval prior to the start of this work.
- N. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- O. Correct areas that are over-excavated.
 - 1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- P. Compaction Density Unless Otherwise Specified or Indicated:
 - 1.
 - 2. Trenches under lawns or gardens; around structures, above footings; embankment and rough site grading: 90 percent of maximum dry density
 - 3. At other locations: 85 percent of maximum dry density.
 - 4. The Engineer reserves the right to order additional "In-Place Density" tests over and above those required under this section to determine consistent conformance with the above compaction requirements for each situation.
- Q. Reshape and re-compact fills subjected to vehicular traffic.
- R. Finish grading of all areas disturbed by trenching operations shall be completed within 14 days of pipe installation unless otherwise approved.

3.10 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Reference Section 31 2323 for materials and use.

3.11 TOLERANCES

- A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.12 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Frequency of Tests: one every 100 LF of trench until Backfill and Compaction Method Plan is approved.
 - 1. The Backfill and Compaction Method Plan shall consist of a written description of the materials, methods, and equipment proposed, and test data demonstrating the proposed materials, methods, and equipment provide the levels of compaction required in these documents.
 - 2. Compaction tests shall be conducted at random intervals over the entire trench depth. One compaction test shall be provided every 500 LF of trench after approval of Backfill and Compaction Method Plan.
 - 3. Any change in material or method will result in testing at the 100 LF interval until revised Method is approved
- D. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor").
- E. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- F. Frequency of Tests: _____.

3.13 CLEANING

- A. Leave unused materials in a neat, compact stockpile.
- B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

**SECTION 32 0150.99
SITE RESTORATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Restoration of site.

1.02 RELATED SECTIONS

- A. Section 31 1000 -Site Clearing.
- B. Section 31 2200 -Grading.
- C. Section 31 2316 -Excavation.
- D. Section 31 2323 -Fill and Backfill.

1.03 REFERENCES

- A. New York State Department of Transportation (NYS DOT) Standard Specification - Construction and Materials (US Customary Units)

1.04 GENERAL REQUIREMENTS

- A. The Contractor shall restore the project site to the same conditions he found before commencing his operations or, he shall notify and develop the site to the finished conditions shown on the drawings.
- B. All cultivated lands to be restored as existed prior to start of work. Uncultivated lands to be restored in accordance with Paragraph 3.03.
- C. All landscape work, including transplanting, planting and maintenance of trees, bushes, shrubs, ground covers and lawns, shall be done by or under the supervision of an experienced practicing landscape gardener.
- D. All lawns dug up and/or damaged shall be restored as described in the related sections, including fine grading, topsoil, fertilizing, seeding, planting, mulching, protection and maintenance.
- E. Finish grading of all areas disturbed by trenching operations shall be completed within 14 days of pipe installation unless otherwise approved. All site clean up and restoration shall be completed within this time. No soil disturbed or exposed by the project shall be left unprotected for more than 7 days.
- F. All Asphalt and concrete surfaces damaged are to be repaired or replaced as determined by the Architect and Engineer.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide Provide Manufacturer's name and brand name for the following:
 - 1. Asphalt filler.
 - 2. Asphalt emulsion
 - 3. Portland Cement
 - 4. Pozzolan (Fly Ash).
 - 5. Aggregate Gradation.
 - 6. Admixtures.
 - 7. Proposed mix.

1.06 QUALITY ASSURANCE

- A. Comply with applicable requirements of DOT Section 400 - Bituminous Pavements and Section 500 - Portland Cement Concrete.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Asphalt Filler: NYS DOT Table 702-2 Asphalt Cements, Material Designation 702-077.
- B. Asphalt Emulsion Tack Coat: NYS DOT Section 702, Table 702.9, Material Designation 702-90.

- C. Asphalt concrete top course: NYS DOT Table 401-1, Type 7.
- D. Concrete Materials:
 - 1. See Section 03 3000 Cast in Place Concrete

PART 3 EXECUTION

3.01 AREAS AND FEATURES TO BE RESTORED

- A. All areas, including natural and artificial features occurring thereon, which are damaged or disturbed by the Contractor's operations, shall be restored, repaired or replaced to the same or superior condition which existed prior to construction unless otherwise stated or shown on the Drawings.
- B. Grassed or lawn areas shall be dressed with topsoil, raked, fertilized, seeded, mulched and maintained as specified in related sections. Gardens and similarly cultivated areas shall be dressed with topsoil, raked and new plants and crops of the same species planted during the appropriate time of year to replace the damaged or destroyed vegetation. Existing trees, shrubs', hedges', saplings, vines, groundcover vegetation, etc., shall be reestablished or replaced with new material as ordered by the Engineer/Architect, unless stated otherwise. Restoration of uncultivated lands is specified in Sec. 3.03.
- C. Walls, terraces, fences, mailboxes, ditches, drains, culverts, drives, posts, patios, outdoor recreational equipment, garden decorations and appurtenances, small structures, and all other artificial features shall be repaired, restored or replaced to the same or superior condition which existed prior to construction.
- D. Any property or right-of-way markers/monuments disturbed by the Contractor's operations shall be reset by a Licensed Land Surveyor to their original position at no cost to the Owner.

3.02 AREAS TO BE DEVELOPED

- A. When the project site is to be modified and developed to meet new conditions, the Contractor shall perform all required grading, topsoiling, fertilizing, seeding, planting, mulching and maintenance of areas, all in accordance with the drawings and as specified elsewhere. Unless shown otherwise on the drawings, the entire unpaved area within the grading limits and within the overall areas excavated and backfilled shall be so developed. New landscaping work and artificial features if any are shown on the drawings and specified elsewhere.

3.03 FINE GRADING

- A. Areas requiring topsoil shall be fine graded to within four (4) inches of finished grade to provide a minimum compacted thickness of four (4) inches of topsoil at all locations. All such areas, whether in cut or fill, shall be raked to a depth of one (1) inch be parallel to finished grade as shown or required, and shall be free of all stones roots rubbish and other deleterious material.

3.04 TOPSOILING

- A. Topsoil shall be furnished and spread in the required areas to a depth of approximately five (5) inches unless otherwise specified. Stockpiled topsoil may be used if it is acceptable to the Engineer. In the event this topsoil is not satisfactory, or is inadequate to cover the required areas, the Contractor shall furnish the required amount of satisfactory topsoil from approved sources off the site. Topsoil furnished from off site shall be in accordance with Specification Section 31 2323 - Fill and Backfill. Topsoil shall not be delivered or laced in a frozen or muddy condition. The soil shall be uniformly compacted with a light hand roller to a final depth of not less than four (4) inches. When finished, the surface shall conform to the finished grades shown or required and shall have a smooth pulverized surface at the time of seeding. Any irregularities shall be corrected before the fertilizer and seed are placed. Any subsequent settlement or displacement of the topsoil shall be restored to an acceptable condition at the Contractor's expense.

3.05 FERTILIZING

- A. Fertilizer shall be a complete, partially organic, commercial fertilizer, containing at least 15% nitrogen (minimum 25% slow release), 30% available phosphorous and 15% potash. The Contractor shall furnish an analysis of the topsoil and fertilizer. The fertilizer shall be uniformly spread by a mechanical spreader at the rate of 3.4 pounds per 1000 square feet. The fertilizer shall be incorporated into the upper two (2) inches of topsoil immediately after spreading.

3.06 SEEDING

- A. The seed used on this project shall be fresh, recleaned and of the latest crop year. It shall conform to Federal and State standards. Each type of grass in the mixture shall meet or exceed the minimum percentage of purity and germination listed for that type of grass with a maximum weed content of 0.1%. Seed shall be applied at a rate of not less than 5 lbs. per 1,000 square feet using a mechanical spreader. The Contractor is advised to do all final seeding during the periods of May 1 to June 15 or August 15 to October 1. Temporary seeding may be conducted during times other than the indicated seeding period for soil stabilization. Establishment of a complete stand of vegetation is the responsibility of the Contractor.
1. Seed Variety:
 - a. Commercial Kentucky Bluegrass:
 - 1) Percent by Weight: 50% +/-.
 - 2) Purity: 95%.
 - 3) Germination: 90%.
 - b. Commercial Creeping Red Fescue:
 - 1) Percent by Weight: 20% +/-.
 - 2) Purity: 95%.
 - 3) Germination: 90%.
 - c. Commercial Perennial Rye Grass:
 - 1) Percent by Weight: 20% +/-.
 - 2) Purity: 95%.
 - 3) Germination: 90%.
 - d. Commercial Delaware Dwarf Rye Grass:
 - 1) Percent by Weight: 10% +/-.
 - 2) Purity: 95%.
 - 3) Germination: 90%.
 - e. Maximum Inert Matter: 1.5%.
 - f. Maximum Weeds, Crop Seeds: 0.3%.
- B. All seed furnished under this item shall be delivered in standard size, unopened bags of the vendor, showing the weight, mixture, vendor's name and guaranteed analysis. Seed shall be properly stored by the Contractor at the site of the contract and any seed damaged during storage shall be replaced by him. Seeding is to be done in dry or moderately dry soil and at times when the wind velocity does not exceed 5 miles per hour. After the finished grading is completed and just before seeding, the areas to be seeded shall be loosened to a depth of two (2) inches and raked to true lines, free from all variation, bumps, ridges and depressions which will hold water. All sticks, stones roots, or other objectionable materials, which might interfere with the formation of the fine seed bed, shall be removed from the soil. Upon completion of the seeding, the area shall be raked lightly and rolled with a light hand roller.

3.07 PLANTING

- A. The Contractor shall reestablish all existing trees, shrubs, vines and ground covers as practicable. He shall provide additional or modify existing vegetation, as outlined in the Special Requirements or shown on the drawings, the size of the new plant material shall, if practical, match that of the item being replaced, consistent with normally available sizes from nursery stock. Depending on the size and type of material, and when ordered by the Engineer, guy wires stakes, anchors and wrapping shall be furnished and installed in a proper manner to brace and protect the plant. The Contractor shall, as soon as practicable, water and maintain all reestablished, replaced or disturbed plant materials until final acceptance of total contract.
- B. Any new, reestablished, replaced or disturbed plant material that fails to respond properly within the one-year guarantee period shall be replaced as specified above at the Contractor's expense. Classifications of plants, dimensions, planting procedures etc. shall conform to ANSI Standard Z-60.1, "Nursery Stock".

3.08 MULCHING, PROTECTION AND MAINTENANCE

- A. The Contractor shall protect and maintain seeded areas to assure a full even stand of grass. Immediately after seeding and rolling, the Contractor shall apply stalks of oats, wheat rye or other approved crops free from noxious weeds as a mulch, to a loose depth of about one inch. The Contractor shall perform all watering, mowing and reseeded as necessary for a minimum of 30 days, and until final acceptance of the Contract, to ensure the establishment of a uniform stand of specified grasses. Upon completion of the contract, the Contractor is required to mow all seeded areas uniformly germinated to a height of 1-1/4 inches to 2 inches and to remove all excess mulch.
- B. Any portion of seeded areas failing to produce a full uniform stand of grass from any cause, shall be reseeded at full rate and refertilized at one-half rate and protected and maintained until such full stand has been obtained.

3.09 RESTORATION OF UNCULTIVATED LANDS

- A. Unless otherwise stated or shown on the drawings, areas of uncultivated land shall be restored as follows. The disturbed surfaces shall be rough-graded to the original elevations and general appearance which existed prior to construction (or to the new elevations and grades which are required), all debris, large stones (greater than 1" in diameter), boulders, etc., being removed in the process. The surface shall then be seeded with perennial rye grass, being spread at the rate of 1 lb. per 800 square feet.
- B. In all cases where brand names and/or manufacturers are specified, it shall be the intent of these specifications that the words "or equal" shall apply.

3.10 REPAIR/RESTORATION OF ASPHALT AND PORTLAND CEMENT CONCRETE SURFACES

- A. Conditioning of Existing Pavement: Comply with NYS DOT Section 633.
- B. Applying Asphalt Emulsion Tack Coat: Comply with NYS DOT Section 407.
- C. Cold Milling: Comply with NYS DOT Section 490.
- D. Lay asphalt concrete top course in accordance with NYS DOT Section 401-3.
 - 1. Cut out damaged damaged asphalt pavement surfaces. Prepare sub-base and adjacent surface. Install approved asphaltic concrete mix in accordance with NYS DOT Section 401.
- E. Cut out damaged portland cement concrete surfaces. Prepare sub-base and adjacent concrete surfaces. Apply bonding agent to adjacent concrete surface to receive fresh portland cement concrete. Install approved portland cement concrete mix in accordance with Section 03 3000 Cast-in-Place Concrete.

END OF SECTION

**SECTION 321150
HOT MIXED ASPHALT PAVING**

PART 1 GENERAL

1.01 SUMMARY AND RELATED REQUIREMENTS

- A. Drawings and general provision of Contract, including Division-01, General Requirements, apply to work of this section.
- B. Refer to other section of the specification, drawings, and details to determine type and extent of work there if affecting the work of this section, whether or not such work is specifically mentioned in this section. It is the intent of this specification to include labor and material required to complete this section whether or not it is clearly or explicitly shown.
- C. Extent of work includes, but not limited to the following:
 - 1. Proof rolling of prepared subbase.
 - 2. Saw-cutting of edges of existing pavement.
 - 3. Hot-mixed asphalt paving over prepared subbases, including blending and patching to existing milling and resurfacing.
- D. Related Requirements: Section 312000, "Earth Moving"

1.02 SUBMITTALS

- A. Submit the following in accordance with General Conditions of Contract
- B. Material Certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

1.03 SITE CONDITIONS

- A. Weather Limitations
 - 1. Apply prime and tack coats when ambient temperature is above 50°F and when temperature has not been below 35°F for 12 hours immediately prior to application. Do not apply when base is wet or contains and excess of moisture.
 - 2. Construct hot-mix asphalt surface course when atmospheric temperature is above 50°F and when base is dry. Base course may be placed when air temperature is above 40°F and rising.
- B. Grade Control
 - 1. Establish and maintain required lines and elevations.

1.04 QUALITY ASSURANCE

- A. Comply with NYSDOT Specifications 401-3.14 and 401-3.15
- B. Personnel and equipment
 - 1. Responsible personnel in charge of paving operations and controlling screed adjustments shall have a minimum of two years' experience of similar work.
 - 2. Operators of paving equipment and rollers shall have a minimum of 5 years' experience on similar work.
 - 3. Use equipment adequate to complete work in a timely manner.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Asphalt Pavement: Paving materials shall comply with the New York State Department of Transportation Standard Specification Section 400 for the materials indicated
 - 1. Use aggregate and PG binder from suppliers listed in the NYS DOT's Approved List for Fine and Coarse Aggregates and Performance Graded (PG) Binders for Warm Mix Asphalt (WMA) Technology for paving respectively. Use of mineral filler or any other materials for the production of asphalt will be accepted in accordance with the State's written instructions.

2. Supply approved asphalt mixtures that meet the requirements of NYSDOT MM 5.16 Superpave Hot Mix Asphalt Mixture Design and Mixture Verification Procedures. Each mixture must be obtained from a single plant for the duration of the project. The following NYSDOT items shall be utilized for this project:
 - a. 19 Binder course
 - b. 9.5 Top course
- B. Coatings: Comply with the NYSDOT Standard Specification, Section 702 for material designations indicated.
 1. Tack Coatings: Emulsified asphalt slow setting type, NYSDOT designation 702-3601 (SS-1h) or 702-4501 (CSS-1h)

PART 3 EXECUTION

3.01 SURFACE PREPARATION

- A. General
 1. Remove loose material from compacted subbase surface immediately before proceeding with work.
 2. Examine areas and conditions which work of this section will be performed. Correct conditions which are detrimental to timely and proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 FINAL PREPARATION OF SUBGRADE

- A. Compact subgrade at completion of excavation with 10-ton roller to 95% maximum density; grade surface. Cut, trim, and roll subgrade so that grades and pitches indicated for final pavement will be reflected in subgrade, before foundation course material is placed. Remove and replace soft or defective subgrade material.
- B. Place the foundation course material. During construction, maintain lines and grade including crown and cross slopes of foundation course by means of line and grade stakes.
- C. If required, obtain, and deliver to Landscape Architect-Engineer a signed report from a testing laboratory APPROVED BY Landscape Architect-Engineer on the status of the prepared subgrade, at no expense to the Owner.
- D. For areas to be overlaid remove loose, crumbling asphalt and sweep area thoroughly.

3.03 PLACEMENT OF ASPHALT CONCRETE PAVING

- A. Apply tack coat just prior to paving when more than 48 hours have passed between pavement applications. Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at rate of 0.05 to .15 gal. per sq. yd. of surface.
- B. Allow to dry until at proper condition to receive paving.
- C. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.
- D. Adjust manhole and catch basin frames, water valves, etc. to meet final grade.
- E. Course thickness, as shown on Contract Drawings details, are compacted depth.
- F. Receipt of asphalt concrete materials
 1. Material will not be accepted unless covered with a tarpaulin until unloaded, and material has a temperature of 250-325°F.
 2. Do not begin placement of asphaltic concrete materials when atmospheric temperature is below 40°F for base course or is below 45°F for top course, nor during fog, rain, or other unsuitable conditions.
 3. Spread materials with the least amount of handling.

- G. Rolling
1. After material has been spread to proper depth, roll until surface is hard, smooth, unyielding, and true to thickness and elevation shown on Contract Drawings.
 2. Roll in at least two directions until no roller marks are visible.
 3. Provide finished paving free from birdbaths. Repair deviations greater than ¼" in 16'-0"
 4. Check with 16' straight edge. Correct all lumps or depressions greater than ¼".
 5. Remove and replace top of binder course pavement that is poorly finished, heaved, crazed, settled, or rutted.
 - a. Delivery/quantity slips for materials used must be delivered to architect as material is placed or before the end of that working day.
 - b. After placement of asphalt, all seams between existing and new pavement areas are to be sealed to prevent deterioration.

3.04 FIELD QUALITY CONTROL

- A. General
1. Testing in-place hot-mixed asphalt courses for compliance with requirements for thickness and surface smoothness will be done by Owner's testing laboratory. Repair or remove and replace unacceptable paving as directed by Landscape Architect-Engineer.
 2. Thickness
 - a. In-place compacted thickness tested in accordance with ASTM D 3549 will not be acceptable if exceeding following allowance variations:
 - 1) Base Course: Plus, or minus ¼"
 - 2) Surface Course: Plus, or minus ¼"
 3. Surface Smoothness
 - a. Test finished surface of each hot-mixed asphalt course for smoothness, using 10' straight edge applied parallel with and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerance for smoothness:
 - 1) Base Course Surface: 1/2"
 - 2) Wearing Course Surfaces: 3/16"
 - b. Check surface areas at intervals as directed by Architect.
 - c. Blend all new work smoothly to existing surfaces to approval of Landscape Architect-Engineer.

3.05 PROTECTION

- A. Protect newly paved areas from traffic until pavement is set, cured and does not pick up under foot or wheeled traffic.

3.06 ADJUST AND CLEAN

- A. Contractor is responsible for correction of all work, which does not conform to the specified requirements.
- B. Remove all rubbish, trash, and debris resulting from operations. Remove unused materials, equipment and implement of service. Leave entire area in neat, clean, and acceptable condition, ready for subsequent operations.
- C. Proof-roll prepared subbase surface to check for unstable areas and areas requiring additional compaction.

END OF SECTION

**SECTION 32 1293.10
ARTIFICIAL GRASS FIELDTURF
SLIT-FILM/MONOFILAMENT
FTVTP-1: VERTEX PRIME**

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, tools and equipment necessary to install slit-film/monofilament artificial grass FieldTurf as indicated on the plans and as specified herein; including components and accessories required for a complete installation including but not limited to
 - 1. Acceptance of prepared sub-base.
 - 2. Coordination with related trades to ensure a complete, integrated, and timely installation: Aggregate base course, sub-base material (tested for permeability), grading and compacting, piping and drain components (when required); as provided under its respective trade section.

1.02 RELATED SECTIONS

- A. Section 31 2000 – Earth Moving

1.03 REFERENCE STANDARDS

- A. FM Factory Mutual
 - 1. P7825 - Approval Guide; Factory Mutual Research Corporation; current edition
- B. ASTM – American Society for Testing and Materials.
 - 1. D1907 - Standard Test Method for Denier
 - 2. D5848 - Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Covering
 - 3. D1338 - Standard Test Method for Tuft Bind of Pile Yarn Floor Covering
 - 4. D1682 - Standard Method of Test for Breaking Load and Elongation of Textile Fabrics
 - 5. D5034 - Standard Test Method of Breaking Strength and Elongation of Textile Fabrics (Grab Test)
 - 6. F1551 - Test Methods for Water Permeability of Geotextiles by Permittivity
 - 7. D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
 - 8. F355 - Standard Test Method for Shock-Absorbing Properties of Playing Surfaces.
 - 9. F1936 - Standard Test Method for Shock-Absorbing Properties of North American Football Field Playing Systems as Measured in the Field

1.04 SUBMITTALS

- A. Substitutions: Other products are acceptable if in compliance with all requirements of these specifications. Submit alternate products to Architect for approval prior to bidding in accordance Section 01 25 13, Product Substitution Procedures.
 - 1. Provide substantiation that proposed system does not violate any other manufacturer's patents, patents allowed or patents pending.
 - 2. Provide a sample copy of insured, non-prorated warranty and insurance policy information.
- B. Comply with Section 01 33 00, Submittals Procedures. Submit for approval prior to fabrication.
- C. Shop Drawings:
 - 1. Indicate field layout; field marking plan and details for the specified sports; i.e., NCAA Football; roll/seaming layout; methods of attachment, field openings and perimeter conditions.
 - 2. Show installation methods and construction indicating field verified conditions, clearances, measurements, terminations, drainage.
 - 3. Provide joint submission with related trades when requested by Architect.
- D. Product Data: Due at time of Bid

1. Submit manufacturer's catalog cuts, material safety data sheets (MSDS), brochures, specifications; preparation and installation instructions and recommendations; storage, handling requirements and recommendations.
 2. Submit fiber manufacturer's name, type of fiber and composition of fiber.
 3. Submit cryogenic suppliers name, sieve analysis and origin of materials.
 4. Submit data in sufficient detail to indicate compliance with the contract documents.
 5. Submit manufacturer's instructions for installation.
 6. Submit manufacturer's instructions for maintenance for the proper care and preventative maintenance of the synthetic turf system, including painting and markings.
 7. Submit certification from the manufacturer that lead or lead chromate is not used in the manufacture of the Turf
- E. Samples: Submit a synthetic turf sample, 12 x 12 inches, representing the turf carpet portion of the product proposed for this project.
- F. Product Certification: Due at time of Bid
1. Submit manufacturer's certification that products and materials comply with requirements of the specifications.
 2. Submit test results indicating compliance with Reference Standards.
- G. Project Record Documents: Record actual locations of seams, drains and other pertinent information in accordance with Specifications, General Requirements.
- H. List of existing installations: Due at time of Bid. Submit list including respective Owner's representative and telephone number.
- I. Warranties: Submit warranty and ensure that forms have been completed in Owner's name and registered with approved manufacturer.
- J. Submit Bills of Lading/Material Delivery Receipts for synthetic turf infill materials. Bills of lading shall bear the name of the project/delivery address, quantity of materials delivered, source/location of origin of infill materials and/or manufacturer, and date of delivery.
- K. Testing Certification: Due at time of Bid. Submit certified copies of independent (third-party) laboratory reports on ASTM testing:
1. Pile Height, Face Weight & Total Fabric Weight, ASTM D5848.
 2. Primary & Secondary Backing Weights, ASTM D5848.
 3. Tuft Bind, ASTM D1335.
 4. Grab Tear Strength, ASTM D1682 or D5034.
 5. Water Permeability, ASTM F1551
- L. The Turf Vendor shall submit a document holding the Owner and it's representatives harmless as to any liability and or costs of any type, including but not limited to legal costs, royalties, replacement costs, etc. associated with any claim by the Turf Vendor or others associated and with any patents or infringements of any current or future patent issued for the synthetic turf product, infill materials, installation methods or drainage characteristics. It is not the intent of these documents to promote or induce the use of intellectual property belonging to others or promote infringement of any known or currently not known patents, licenses or rights of others.

1.05 QUALITY ASSURANCE

- A. Comply with Section 01 43 00, Quality Assurance.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section. The turf contractor and/or the turf manufacturer:
1. Shall be experienced in the manufacture and installation of specified type of infilled slit-film/monofilament synthetic grass system for a minimum of three years. This includes a slit-film/monofilament fiber, backing, the backing coating, and the installation method.

2. The manufacturer must have ISO 9001, ISO 14001 and OHSAS 18001 certifications demonstrating its manufacturing efficiency with regards to quality, environment and safety management systems.
 3. The manufacturer must be a Preferred Producer by all of the following major international governing bodies: FIFA, World Rugby, International Hockey Federation (FIH)
 4. Shall have a minimum of 50 installations in the State/Province of New York.
 5. Shall have a minimum of 1 FIFA Quality Pro recommended field in North America.
 6. Manufacturer must provide proof that its turf systems have been subject to long-term independent, epidemiological and peer reviewed studies proving its ability to provide for a safe surface.
 7. Manufacturer must have available a program, certified by Carbonfund.org, to offset the complete CO2e emissions that will result from this specific project, including the field's specific materials, manufacturing and installation. Carbon Offsets are to be provided through the Carbonfund Foundation's Carbonfree® Partner Program, which funds third-party validated and verified renewable energy, forestry, and energy efficiency projects supporting a low carbon transition for the planet. Costs for the Carbon offset program to be included as a line item in the pricing proposal / submission.
- C. Installer: Company shall specialize in performing the work of this section. The Contractor shall provide competent workmen skilled in this specific type of synthetic grass installation.
1. The designated Supervisory Personnel on the project shall be certified, in writing by the turf manufacturer, as competent in the installation of specified slit-film/monofilament material, including sewing seams and proper installation of the infill mixture.
 2. Installer shall be certified by the manufacturer and licensed.
 3. The installer supervisor shall have a minimum of 5 years experience as either a construction manager or a supervisor of synthetic turf installations
- D. Pre-Installation Conference: Conduct conference at project site at time to be determined by Architect. Review methods and procedures related to installation including, but not limited to, the following:
1. Inspect and discuss existing conditions and preparatory work performed under other contracts.
 2. In addition to the Contractor and the installer, arrange for the attendance of installers affected by the Work, The Owner's representative, and the Architect.
- E. The Contractor shall verify special conditions required for the installation of the system.
- F. The Contractor shall notify the Architect of any discrepancies.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 60 00, Product Requirements.
- B. Prevent contact with materials that may cause dysfunction.
- C. Deliver and store components with labels intact and legible.
- D. Store materials/components in a safe place, under cover, and elevated above grade.
- E. Protect from damage during delivery, storage, handling and installation. Protect from damage by other trades.
- F. Inspect all delivered materials and products to ensure they are undamaged and in good condition.
- G. Comply with manufacturer's recommendations.

1.07 SEQUENCING AND SCHEDULING

- A. Coordinate the Work with installation of work of related trades as the Work proceeds.
- B. Sequence the Work in order to prevent deterioration of installed system.

1.08 WARRANTY AND GUARANTEE

- A. See Section 01780 - Closeout Submittals, For Additional Warranty Requirements.

- B. The Contractor shall provide a warranty to the Owner that covers defects in materials and workmanship of the turf for a period of eight (8) years from the date of substantial completion. The turf manufacturer must verify that their representative has inspected the installation and that the work conforms to the manufacturer's requirements. The manufacturer's warranty shall include general wear and damage caused from UV degradation. The warranty shall specifically exclude vandalism, and acts of God beyond the control of the Owner or the manufacturer. The warranty shall be fully third party insured; prepaid for the entire 8 year term and be non-prorated. The Contractor shall provide a warranty to the Owner that covers defects in the installation workmanship, and further warrant that the installation was done in accordance with both the manufacturer's recommendations and any written directives of the manufacturer's representative. Prior to final payment for the synthetic turf, the Contractor shall submit to owner notification in writing that the field is officially added to the annual policy coverage, guaranteeing the warranty to the Owner. The insurance policy must be underwritten by an "AM Best" A rated carrier and must reflect the following values:
- Pre-Paid 8-year insured warranty from a single source.
 - Maximum per claim coverage amount of \$15,000,000.
 - Minimum of fifteen million dollars (\$15,000,000) annual.
 - Must cover full 100% replacement value of total square footage installed, minimum of \$7.00 per sq ft. (in case of complete product failure, which will include removal and disposal of the existing surface)
 - Provide a sample copy of insured, non-prorated warranty and insurance policy information.
 - Policy cannot include any form of deductible to be paid by the Owner.
- C. The artificial grass system must maintain a G-max of less than 200 for the life of the Warranty as per ASTM F1936.

1.09 MAINTENANCE SERVICE

- A. Contractor shall train the Owner's facility maintenance staff in the use of the turf manufacturer's recommended maintenance equipment.
- B. Manufacturer must provide maintenance guidelines and a maintenance video to the facility maintenance staff.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Approved manufacturers are as follows:
1. FieldTurf USA Inc. | 175 N. Industrial Blvd | Calhoun, GA 30701 | P: 800-724-2969
 - a. Model: FieldTurf Vertex Prime 2.5"

2.02 MATERIALS AND PRODUCTS

- A. Artificial grass FieldTurf system materials shall consist of the following:
1. Carpet made of slit-film and monofilament polyethylene fibers tufted together into each individual stitch, into a non-perforated backing. Alternating row monofilament and slit-film carpet constructions are not permitted.
 2. Infill: graded sand and cryogenic rubber crumb that partially covers the carpet.
 3. Glue, thread, paint, seaming fabric and other materials used to install and mark the artificial grass slit-film/monofilament FieldTurf.
- B. The installed artificial grass slit-film/monofilament FieldTurf shall have the following properties:

<u>Standard</u>	<u>Property</u>	<u>Specification</u>
	Pile Yarn Type	UV-resistant polyethylene

ASTM D1907	Yarn Structure – A	Slit-Film
	Yarn Denier - A	5,000
	Yarn Structure – B	Ridged Monofilament
	Yarn Denier – B	14,500
ASTM D5823	Min. Pile Height	2.5”
ASTM D1577	Fiber Thickness A/B	130/360+ Microns
ASTM D5793	Stitch Gauge	3/4”
ASTM D5848	Pile Weight	47+oz/square yard
ASTM D5848	Primary Backing	7+oz/square yard
ASTM D5848	Secondary Backing	14+oz/square yard
ASTM D5848	Total Weight	68+oz/square yard
ASTM D1335	Tuft Bind (Without Infill)	8+lbs
ASTM D5034	Grab Tear (Width)	200 lbs/force
ASTM D5034	Grab Tear (Length)	200 lbs/force
ASTM F1551	Carpet Permeability	>40 inches/hour
ASTM F1936	Impact Attenuation (Gmax)	<200
	Min. Infill Material Depth	1.75 inches
	Min. Sand Infill Component	6.2lbs/square foot
	Min. Cryogenic Rubber Infill	3lbs/square foot
	Total Product Weight	1393oz/square yard

Variation of +/- 5% on above listed properties is within normal manufacturing tolerances

- C. Carpet shall consist of slit-film/monofilament fibers tufted into a primary backing with a secondary backing.
- D. Carpet Rolls shall be 15’ wide rolls.
 - 1. Rolls shall be long enough to go from field sideline to sideline.
 - 2. Where the playing field is for football, the perimeter white line shall be tufted into the individual sideline rolls.
- E. Backing:
 - 1. Primary backing shall be a minimum double-layered polypropylene fabric
 - 2. Secondary backing shall permanently lock the fiber tufts in place.
 - 3. Perforated (with punched holes), backed carpet are unacceptable.
- F. Fibers shall be measuring no less than 2 1/2 inches high.
 - 1. Systems with less than a 2 1/2 inch fibers are unacceptable.
- G. Infill materials shall be approved by the manufacturer.
 - 1. Infill shall consist of a resilient granular system, comprising selected and graded sand and cryogenically hammer-milled SBR rubber crumb.
 - 2. Artificial Grass products without cryogenically processed rubber shall not be accepted.
- H. The sand infill will comply within the following characteristics:
 - Average Particle size between 20 and 30 mesh [calculated based on summing the midpoint of sieve pan fractions times the % retained on given screen fractions]
 - Average Particle shape > 0.4 on the Krumbein scale

- Particle structure predominantly single grain
 - Produce < 0.4%, -50M in API crush test at 80psig
- I. Non-tufted or inlaid lines and markings shall be painted with paint approved by the synthetic turf manufacturer.
 - J. Thread for sewing seams of turf shall be as recommended by the synthetic turf manufacturer.
 - K. Glue and seaming fabric for inlaying lines and markings shall be as recommended by the synthetic turf manufacturer.

2.03 QUALITY CONTROL IN MANUFACTURING

- A. The manufacturer shall own and operate its own manufacturing plant. Manufacturing the fiber, tufting of the field fibers into the backing materials and coating of the turf system must be done in-house by the turf manufacturer. Outsourcing of any of these major processes is unacceptable.
- B. The manufacturer shall have full-time certified in-house inspectors at their manufacturing plant that are experts with industry standards.
- C. Primary backing shall be inspected by the manufacturer's full-time certified in-house inspectors before tufting begins.
- D. The manufacturer's full-time in-house certified inspectors shall verify "pick count", yarn density in relation to the backing, to ensure the accurate amount of face yarn per square inch.
- E. The manufacturer's full-time, in-house, certified inspectors shall perform turf inspections at all levels of production including during the tufting process and at the final stages before the turf is loaded onto the truck for delivery.
- F. The manufacturer shall have its own, in-house laboratory where samples of turf are retained and analyzed, based on standard industry tests, performed by full-time, in-house, certified inspectors.
- G. The manufacturer must have ISO 9001, ISO 14001 and OHSAS 18001 certifications demonstrating its manufacturing efficiency with regards to quality, environment and safety management systems.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that all sub-base leveling is complete prior to installation.
- B. Installer shall examine the surface to receive the synthetic turf and accept the sub-base planarity in writing prior to the beginning of installation.
 1. Acceptance is dependent upon the Owner's test results indicating compaction and planarity are in compliance with manufacturer's specifications.
 2. The surface shall be accepted by Installer as "clean" as installation commences and shall be maintained in that condition throughout the process.
- C. Compaction of the aggregate base shall be 95%, in accordance with ASTM D1557 (Modified Proctor procedure); and the surface tolerance shall not exceed 0-1/4 inch over 10 feet and 0-1/2" from design grade.
- D. Correct conditions detrimental to timely and proper completion of Work.
- E. Do not proceed until unsatisfactory conditions are corrected.
- F. Beginning of installation means acceptance of existing conditions.

3.02 PREPARATION

- A. Prior to the beginning of installation, inspect the sub-base for tolerance to grade.
- B. Sub-base acceptance shall be subject to receipt of test results (by others) for compaction and planarity that sub-base is in compliance with manufacturer's specifications and recommendations.

- C. Dimensions of the field and locations for markings shall be measured by a registered surveyor to verify conformity to the specifications and applicable standards. A record of the finished field as-built measurements shall be made.
- D. When requested by Architect, installed sub-base shall be tested for porosity prior to the installation of the slit-film/monofilament turf. A sub base that drains poorly is an unacceptable substrate

3.03 INSTALLATION - GENERAL

- A. The installation shall be performed in full compliance with approved Shop Drawings.
- B. Only trained technicians, skilled in the installation of athletic caliber synthetic turf systems working under the direct supervision of the approved installer supervisors, shall undertake any cutting, sewing, gluing, shearing, topdressing or brushing operations.
- C. The designated Supervisory personnel on the project must be certified, in writing by the turf manufacturer, as competent in the installation of this material, including sewing seams and proper installation of the Infill mixture.
- D. Designs, markings, layouts, and materials shall conform to all currently applicable National Collegiate Athletic Association rules, NFHS rules, and/or other rules or standards that may apply to this type of synthetic grass installation. Designs, markings and layouts shall first be approved by the Architect or Owner in the form of final shop drawings. All markings will be in full compliance with final shop drawings.

3.04 INSTALLATION

- A. Install at location(s) indicated, to comply with final shop drawings, manufacturers'/installer's instructions.
- B. The Contractor shall strictly adhere to specified procedures. Any variance from these requirements shall be provided in writing, by the manufacturer's on-site representative, and submitted to the Architect and/or Owner, verifying that the changes do not in any way affect the Warranty. Infill materials shall be approved by the manufacturer and installed in accordance with the manufacturer's standard procedures.
- C. Carpet rolls shall be installed directly over the properly prepared aggregate base. Extreme care shall be taken to avoid disturbing the aggregate base, both in regard to compaction and planarity.
 - 1. Repair and properly compact any disturbed areas of the aggregate base as recommended by manufacturer
- D. Full width rolls shall be laid out across the field.
 - 1. Turf shall be of sufficient length to permit full cross-field installation from sideline to sideline.
 - 2. Each roll shall be attached to the next roll utilizing standard state-of-the- art sewing procedures.
 - 3. When all of the rolls of the playing surface have been installed, the sideline areas shall be installed at right angles to the playing surface.
- E. Artificial turf panel seams shall be sewn along the selvedge edging flap of the turf roll. Seams secured by other means including gluing are unacceptable. Installation shall be 99% sewn.
 - 1. Minimum gluing will only be permitted to repair problem areas, corner completions, and to cut in any logos or inlaid lines as required by the specifications.
 - 2. Seams shall be flat, tight, and permanent with no separation or fraying.
 - 3. In the case of all lines and logos, turf carpet/field fibers must be sheared to the backing (do not cut the backing) and adhered using hot melt adhesives.
- F. Infill Materials:
 - 1. Infill materials shall be applied in numerous thin lifts. The turf shall be brushed as the mixture is applied.

2. Infill materials shall be installed to fill the voids between the fibers and allow the fibers to remain vertical and non-directional. The Infill installation consists of sand and cryogenically processed rubber. The Infill shall be installed to a minimum depth of 1 3/4".
- G. Non-tufted or inlaid lines and markings shall be painted in accordance with turf and paint manufacturers' recommendations. Number of applications will be dependent upon installation and field conditions.
- H. Synthetic turf shall be attached to the perimeter edge detail in accordance with the manufacturer's standard procedures.
- I. Upon completion of installation, the finished field shall be inspected by the installation crew and an installation supervisor.

3.05 FIELD MARKINGS

- A. Field markings shall be installed in accordance with approved shop drawings. If football is designated as the primary sport, all five yard lines will be tufted-in.
- B. Balance of sports markings will be inlaid or painted in accordance with the Drawings.
- C. Center field logo shall be either painted or inlaid according to artwork indicated on Drawings and in accordance with manufacturer's standard palette of turf colors.
- D. End-zone letters and logos shall be either painted or inlaid according to artwork and fonts indicated on the Drawings, and in accordance with manufacturer's standard palette of turf colors.

3.06 ADJUSTMENT AND CLEANING

- A. Do not permit traffic over unprotected surface.
- B. Contractor shall provide the labor, supplies, and equipment as necessary for final cleaning of surfaces and installed items.
- C. All usable remnants of new material shall become the property of the Owner.
- D. The Contractor shall keep the area clean throughout the project and clear of debris.
- E. Surfaces, recesses, enclosures, and related spaces shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

3.07 PROTECTION

- A. Protect installation throughout construction process until date of final completion.

END OF SECTION

**SECTION 321330
CONCRETE PAVING**

PART 1 GENERAL

1.01 SUMMARY AND RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary
- B. Conditions and other Division 01 Specification Sections, apply to this Section.
- C. Refer to other sections of the specifications, drawings and details to determine type and extent mentioned in this section. It is the intent of this specification to include all labor and material required to complete this section whether or not it is clearly or explicitly shown
- D. This section includes the installation of concrete sidewalks and pads as shown on the Drawings, or as specified herein.
- E. The materials and methods specified herein are directly intended for placement of “new” concrete sidewalks and pads. Where existing sidewalk is removed and replaced during construction, modifications to these specifications to match existing conditions shall be made as directed by the Landscape Architect.
- F. Related Requirements:
 - 1. Section 312000 – “Earth Moving”
 - 2. Section 321823.53 – “Concrete Tennis Court Surface Color Coating System”

1.02 QUALITY ASSURANCE

- A. Reference Standards
 - 1. The latest edition of the following standards, as referenced herein, shall be applicable.
 - a. “Standard Specifications, Construction and Materials, New York State Department of Transportation, Office of Engineering.”
- B. American Society of Testing and Materials (ASTM).
- C. American Concrete Institute (ACI).
- D. The Contractor shall provide and pay for all costs in connection with an approved independent testing facility to determine conformance of materials with the specifications, if at any time during the Work materials appear unsuitable in the opinion of the Architect.

1.03 SUBMITTALS

- A. Concrete
 - 1. The Contractor shall furnish the name and location of the concrete supplier. Submit the design mix for each class of concrete prior to use in the Work.
- B. Product Data
 - 1. Submit color samples to architect for approval prior to use in the Work. Samples to be 1’x1’ and to be a mock-up other than in the field.
- C. Test Results
 - 1. The testing laboratory shall submit written reports of all tests, investigations, and recommendations to the Contractor and the Landscape Architect.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete
 - 1. All cast-in-place concrete shall be ready mixed concrete meeting the following criteria:
 - a. 28-day compressive strength – 4000 psi
 - b. Air entrainment – 4% to 8%

- c. Slump – 2” to 4”
- B. Concrete Color Pigments
 - 1. As supplied by Davis Colors, telephone 800-356-4843, www.daviscolors.com or approved equal.
- C. Premolded Expansion Joint Filler
 - 1. Concrete sidewalks shall be provided with a ½” premolded expansion joint filler confirming to ASTM D1751.
 - 2. The premolded expansion joint filler shall be “pre-cut” to match the concrete sidewalk cross-sectioned dimension as detailed on the Drawings.
- D. Fabric Reinforcement
 - 1. Flat sheets of 6 x 6 – W 2.9xW2.9, ASTM A 185, welded wire fabric.
- E. Sealants
 - 1. Joint Sealers: ASTM D 1850
- F. Forms
 - 1. Sidewalk forms shall be of wood or steel, straight of sufficient strength to resist springing during depositing and consolidating concrete, and of a height equal to the full depth of the finished sidewalk.
 - 2. Wood forms shall be surfaced plank, 2-inch nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet, with a minimum of four stakes per form, at maximum spacing of 3 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Radius bends may be formed with three-quarter inch boards, laminated to the required thickness.
 - 3. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Form ends shall be interlocked and self-aligning. Forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Forms shall have a minimal length of 10 feet, with a minimum of two welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips, designed for use with steel forms

PART 3 EXECUTION

3.01 INSPECTION

- A. The Contractor shall notify the Architect 24 hours before placing concrete in order to give the Architect an opportunity to inspect the formwork, reinforcing and related items prior to placement of the concrete.
- B. Delivery tickets shall show the amount of cement, brand, and amount of all admixtures, in addition to information required by ASTM C94, Section 14. Water added on the job shall be approved and the amount noted on the delivery ticket and initialed by the Contractor.

3.02 SUBBASE PREPARATION

- A. Concrete sidewalk shall be constructed on a compacted granular subbase as shown on the drawings.
- B. The completed subbase shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.
- C. The subbase shall be maintained in a smooth, compacted condition in conformity with the required section and established grade, until the concrete is placed.
- D. The subbase shall be in a moist condition when concrete is placed.
- E. The subbase shall be prepared and protected so as to produce a subbase free from frost when the concrete is deposited.

3.03 FORMWORK

- A. Earth cuts may not be used as forms for vertical surfaces.

- B. All forms shall be built mortar tight and of materials sufficient in strength to hold concrete without bulging between supports. Forms shall be maintained to eliminate the formation of joints due to shrinkage of the forms. Concrete, misshapen by bulges or deformations caused by inadequate forms, shall be removed or corrected as ordered by the Architect. All replacements or corrections shall be made at the Contractor's expense.
- C. All surfaces of wooden forms that will be in contact with exposed concrete shall be thoroughly treated with an approved lacquer in the procedure recommended by the manufacturer. Forms so treated shall be protected from being damaged or dirtied prior to placing of the concrete.
- D. Metal forms shall be treated with an approved form lacquer or may be treated with an approved form oil. The metal used for forms shall be of sufficient thickness to remain true to shape. All bolt and rivet heads shall be designed to hold the forms rigidly together and to allow removal, without injury to the concrete. Metal forms which do not have smooth surfaces, correct alignment and clean surfaces shall not be used.
- E. Side forms shall not be removed for less than 12 hours after finishing has been completed.

3.04 CONCRETE PLACEMENT AND FINISHING

- A. Preparation
 - 1. Set forms true to line and grade and anchor rigidly in position.
 - 2. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Longitudinal expansion joints shall be installed between concrete sidewalk and abutting concrete curb, continuously. Transverse expansion joints shall be installed equally at not more than 20 feet on center, unless otherwise directed by the Architect, or as detailed on the Drawings.
 - 3. Transverse expansion joints shall be filled with one-half inch joint filler strips. Joint filler shall be placed with top edge one-quarter inch below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Protect the top edge of the joint filler during concrete placement with a temporary cap and remove after concrete has been placed.
 - 4. Expansion joints shall be formed about structures and features that project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. The filler shall be installed in such manner as to form a complete, uniform separation between the structures and sidewalk pavement.
- B. Placement of Fabric Reinforcement
 - 1. Prior to placement, clean reinforcement thoroughly of mill and rust scale and of coatings which could
 - 2. destroy or reduce bond. Where there is a delay in depositing concrete after the positioning or reinforcement, reclean reinforcement, if necessary.
 - 3. Place reinforcement midway between top and bottom of the slab and secure against displacement.
 - 4. Lap edges and ends of adjoining sheets of fabric reinforcement at least half the mesh width. Offset end laps in adjacent sheets to prevent continuous joints at ends. Interrupt reinforcement at expansion joints, stopping 2 inches from edges.
- C. Concrete Placement
 - 1. Concrete shall be placed in the forms in one layer of such thickness that when compacted and finished the sidewalk will be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted.
 - 2. The concrete shall be tamped and consolidated with a suitable wood or metal tamping bar, and the surface shall be finished to grade with a wood float. Finished surface of the walk shall not vary more than 3/16 inch from the testing edge of a 20-foot straightedge. Irregularities exceeding

the above shall be satisfactorily corrected. The surface shall be divided into rectangular areas by means of contraction joints spaced at intervals shown on the drawings.

3. Place concrete in accordance with ACI 301 unless otherwise specified herein.
4. Cold Weather Concrete: Comply with ACI 305 306 for placement at temperatures of, or expected to be, below 40°F.
5. Hot Weather Concrete: Comply with ACI 306 305 for placement at temperature of, or expected to be, above 90°F.

3.05 CONCRETE FINISHING

- A. After straight edging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, or as otherwise shown on the drawings.
- B. All slab edges, including those at formed joints, shall be finished carefully with an edger having a radius of 1/8 inch. Corner and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.
- C. The completed surface shall be uniform in color and free of surface blemishes and tool marks.

3.06 CURING

- A. General
 1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
 2. Comply with ACI 306.1 for cold-weather protection
- B. Evaporation Retarder
 1. Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2lb/sq. ft. x h(1kg/sq.m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding and bull floating or darbying concrete but before float finishing.
 2. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- C. Curing Methods
 1. Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:
 2. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water
 - b. Continuous water-fog spray
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300mm) lap over adjacent absorptive covers.
 3. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300mm) and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation period using cover material and waterproof tape.
 4. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.07 SEALING JOINTS

- A. At the end of the curing period, expansion joints shall be carefully cleaned and filled with joint sealer.

- B. Concrete at the joint shall be surface dry, and the atmospheric and pavement temperatures shall be above 50°F, at the time of application of joint sealing materials.
- C. Joints shall be filled flush with the concrete surface in such manner as to minimize spilling on the walk surface. Spilled sealing material shall be removed immediately and the surface of the walk cleaned. Dummy groove joints shall not be sealed.

3.08 BACKFILLING AND RESTORATION

- A. After curing, debris shall be removed, and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.
- B. All lawns, pavements, driveways, shrubs, or other improvements affected by sidewalk placement shall be restored to their original condition.

3.09 PROTECTION

- A. The Contractor shall protect the curbing and keep it in alignment and “first class” condition until the completion of the Contract. Any curbing, which is damaged prior to final acceptance of the Work, shall be removed and replaced at the Contractor’s expense.

END OF SECTION

**SECTION 321823
SKINNED INFIELD MIX**

PART 1 GENERAL

1.01 SUMMARY AND RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification, apply to this Section.
- B. Related Requirements:
 - 1. Section 312000 – “Earth Moving”

1.02 SUBMITTALS

- A. Samples:
 - 1. Submit soils analysis reports for sample of infield mix from an approved testing laboratory.

1.03 QUALITY ASSURANCE

- A. Infield mix used on this project shall be tested and approved before placement.
- B. Secure approval before delivering infield mix to the project site.

PART 2 PRODUCTS

2.01 INFIELD MIX

- A. Clay Surface
 - 1. Basis of design: Mar-co infield clay 15 series (standard).
- B. Sand Subbase
 - 1. Well blended sand with a gradation as follows:

SIEVE #	PERCENT PASSING
4	99
8	85
16	73
30	60
50	47
100	21
200	8

PART 3 EXECUTION

3.01 PREPARATION

- A. Site Grade
 - 1. The skinned portion should be graded to within 6” of finish grade. The slope should be even and consistent to completely eliminate all depressions and high spots where water may have a tendency to collect or flow. The area should be cleared of any large stones, heavy matter, or clumped earth.

B. Skinned Infield

1. Install infield per detail. After installation, the area shall be dragged with a cocca mat to provide a level smooth grade, completely free of depressions and other surfaces irregularities. The skinned area should then be moistened and rolled. For proper compaction, a uniform moisture content is necessary during rolling. This can be obtained by using a fine nozzle spray to saturate to a depth of approximately 1-1/2". Spraying indirectly on surfaces is necessary to avoid eroding, gouging, or disturbing the finished area. Puddling should be avoided. After proper wetting, rolling should take place using a 1-ton roller assuring upon completion that all surfaces be level and sloped as indicated on the drawings and/or as required for final approval by Landscape Architect.

END OF SECTION

SECTION 321823.53

ASPHALT TENNIS COURT SURFACE COLOR COATING SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Asphalt tennis court surface color coating system.

1.02 RELATED REQUIREMENTS

- A. Section 321150 – Hot Mixed Asphalt Paving

1.03 REFERENCE STANDARDS

- A. American Sports Builders Association (ASBA).
- B. United States Tennis Association (USTA) Rules of Tennis.
- C. International Tennis Federation (ITF).

1.04 SUBMITTALS

- A. Comply with Section 01330 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data, including surface and crack preparation and application instructions.
- C. Samples: Submit manufacturer's color samples of color coating.
- D. Test Reports:
 - 1. Submit independent test results for solar reflectance index.
 - 2. Submit independent test results for 2000 Hour ASTM G154, accelerated weathering UV test, to demonstrate long-term durability and fade resistance.
 - 3. Submit independent test results for 2000 Hour, accelerated weathering ASTM G155 Xenon Arc test, to demonstrate long-term fade resistance and quality of pigment.
- E. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
- F. Manufacturer's Project References: Submit manufacturer's list of successfully completed asphalt tennis court surface color coating system projects, including project name, location, and date of application.
- G. Applicator's Project References: Submit applicator's list of successfully completed asphalt tennis court surface color coating system projects, including project name, location, type and quantity of color coating system applied, and date of application.
- H. Warranty Documentation: Submit manufacturer's standard warranty.
- I. Authorized Installer Certificate: Submit manufacturer's authorized installer certificate.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturer regularly engaged, for past 5 years, in manufacture of asphalt tennis court surface color coating systems of similar type to that specified.
 - 2. United States owned company.
 - 3. Member: ASBA.
 - 4. Manufacturer has surfaces that are classified by the ITF's (International Tennis Federation) pace classification program.
- B. Applicator's Qualifications:
 - 1. Applicator regularly engaged, for past 3 years, in application of tennis court surface color coating systems of similar type to that specified.

2. Employ persons trained for application of tennis court surface color coating systems.
3. Applicator must be authorized installer of the surfacing brand used.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage and Handling Requirements:
 1. Store and handle materials in accordance with manufacturer's instructions.
 2. Keep materials in manufacturer's original, unopened containers and packaging until application.
 3. Store materials in clean, dry area indoors.
 4. Store materials out of direct sunlight.
 5. Keep materials from freezing.
 6. Protect materials during storage, handling, and application to prevent contamination or damage.
 7. Close containers when not in use.
 8. Retain manufacturer batch codes on each container and application dates, for warranty purposes.

1.07 AMBIENT CONDITIONS

- A. Do not apply asphalt tennis court surface color coating system when air or surface temperatures are below 50°F (10°C) during application or within 24 hours after application.
- B. Do not apply asphalt tennis court surface color coating system when rain is expected during application or within 24 hours after application.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. SportMaster Sport Surfaces, PO Box 2277, 2520 South Campbell Street, Sandusky, Ohio 44870. Toll Free 800-326-1994. Fax 877-825-9226. Website: www.sportmaster.net. E-mail moreinfo@sportmaster.net.
- B. All other brands must be pre-approved by the architect/owner, 7 days prior to the bid date. If submitting another brand, bidder must furnish copies of all submittal documents under section 1.4

2.02 MATERIALS

- A. Asphalt Tennis Court Surface Color Coating System: SportMaster Color Coating System.
- B. Crack Sealant: SportMaster "Crack Magic".
 1. 100 percent acrylic emulsion elastomeric crack sealant.
 2. Seals cracks up to 1/2 inch wide in asphalt pavement.
 3. Weight per Gallon at 77 Degrees F: 8.8 lbs., plus or minus 0.5 lbs.
 4. Non-Volatile Material: 61 percent, plus or minus 5 percent.
 5. Color: Neutral
- C. Crack Filler: SportMaster "Acrylic Crack Patch".
 1. 100 percent acrylic emulsion trowel-grade crack filler.
 2. Fills cracks in asphalt pavement up to 1 inch wide.
 3. Chemical Characteristics, by Weight, Minimum:
 - a. Acrylic Emulsion: 10.0 percent.
 - b. Hiding Pigment: 0.2 percent.
 - c. Mineral Inert Fillers: 78.0 percent.
 - d. Film Formers, Additives: 1.8 percent.
 - e. Water: 8.5 percent.
 4. Weight per Gallon at 77 Degrees F: 15.2 lbs., plus or minus 1.0 lbs.

5. Non-Volatile Material: 80 percent, plus or minus 5 percent.
 6. Color: Neutral
- D. Patch Binder: SportMaster "Acrylic Patch Binder".
1. 100 percent acrylic emulsion liquid binder.
 2. Mix on-site with sand and cement.
 3. Levels and repairs low spots and depressions up to 3/4 inch deep in asphalt pavement.
 4. Fills Cracks in Asphalt up to 1" in width.
 5. Weight per Gallon at 77 Degrees F: 8.8 lbs., plus or minus 0.5 lbs.
- E. Filler Course: SportMaster "Acrylic Resurfacer".
1. 100 percent acrylic emulsion resurfacer.
 2. Mix on-site with silica sand.
 3. Apply to asphalt surfaces or previously colored acrylic surfaces in preparation of color coating system.
 4. Chemical Characteristics, by Weight, Minimum:
 - a. Acrylic Emulsion: 44.0 percent.
 - b. Hiding Pigment: 2.0 percent.
 - c. Mineral Inert Fillers: 5.0 percent.
 - d. Film Formers, Additives: 0.2 percent.
 - e. Water: 45.0 percent.
 5. Weight per Gallon at 77 Degrees F: 8.5 lbs., plus or minus 0.5 lbs.
 6. Non-Volatile Material: 27.5 percent, plus or minus 5.0 percent.
 7. Color: Neutral
- F. Color Coating: SportMaster "ColorPlus System".
1. 100 percent acrylic emulsion coating.
 2. Mix on-site with silica sand and water.
 3. Color coats tennis and multipurpose courts.
 4. Weight per Gallon at 77 Degrees F: 9.2 lbs., plus or minus 0.5 lbs.
 5. Color: Light Green
- G. Line Markings Primer: SportMaster "Stripe-Rite".
1. 100 percent acrylic emulsion primer, clear drying.
 2. Primes line markings and prevents bleed-under for sharp lines.
 3. Chemical Characteristics, by Weight, Nominal:
 - a. Acrylic Emulsion: 38.0 percent.
 - b. Hiding Pigment: 0.0 percent.
 - c. Mineral Inert Fillers: 7.0 percent.
 - d. Film Formers, Additives: 1.5 percent.
 - e. Water: 50.0 percent.
 4. Weight per Gallon at 77 Degrees F: 8.9 lbs., plus or minus 0.5 lbs.
 5. Non-Volatile Material: 29 percent, plus or minus 5 percent.
- H. Line Paint: SportMaster "Textured Line Paint".
1. Pigmented, 100 percent acrylic emulsion line paint.
 2. Line marking on asphalt tennis courts.
 3. Chemical Characteristics, by Weight, Nominal:
 - a. Acrylic Emulsion: 25.89 percent.
 - b. Pigment: 14.90 percent.
 - c. Mineral Inert Fillers: 13.12 percent.
 - d. Additives: 4.73 percent.
 - e. Water: 41.36 percent.

4. Weight per Gallon at 77 Degrees F: 10.65 lbs., plus or minus 0.75 lbs.
5. Non-Volatile Material: 45.17 percent, plus or minus 5 percent.
6. Color: White.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine asphalt tennis court surfaces to receive color coating system.
- B. Verify asphalt tennis courts meet ASBA construction requirements.
- C. Notify Architect of conditions that would adversely affect application or subsequent use.
- D. Do not begin surface preparation or application until unacceptable conditions are corrected.

3.02 SURFACE PREPARATION

- A. Protection of In-Place Conditions: Protect adjacent surfaces and landscaping from contact with asphalt tennis court surface color coating system.
- B. Prepare surfaces in accordance with manufacturer's instructions.
- C. Cure new asphalt surfaces a minimum of 14 to 30 days before application of asphalt tennis court surface color coating system.
- D. Remove dirt, dust, debris, oil, grease, vegetation, loose materials, and other surface contaminants which could adversely affect application of asphalt tennis court surface color coating system. Pressure wash entire surface.
- E. Repair cracks, depressions, and surface defects in accordance with manufacturer's instructions before application of filler course and color coating.
- F. Level depressions 1/8 inch and deeper with patch binder in accordance with manufacturer's instructions.
- G. Apply 1 or 2 coats of filler course as required by surface roughness and porosity to provide smooth underlayment for application of color coating.
- H. Ensure surface repairs are flush and smooth to adjoining surfaces.

3.03 APPLICATION

- A. Apply asphalt tennis court surface color coating system in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Mix materials in accordance with manufacturer's instructions.
- C. Apply Filler Course and Color Coating with a 50-60 durometer, soft rubber squeegee.
- D. Filler Course:
 1. Apply 2 coats on new asphalt or existing acrylic surfaces with extensive cracks or low spot repair.
 2. Apply 1 coat on existing acrylic surfaces with minimal repairs.
- E. Color Coating: Apply a minimum of 2 coats of color coating to prepared surfaces in accordance with manufacturer's instructions.
- F. Allow material drying times in accordance with manufacturer's instructions before applying other materials or opening completed surface to foot traffic.

3.04 LINE MARKINGS

- A. Lay out tennis court line markings in accordance with USTA Rules of Tennis.
- B. Apply line markings primer, after masking tape has been laid, to seal voids between masking tape and tennis court surface to prevent bleed-under when line paint is applied.

- C. Apply a minimum of 1 coat of line paint in accordance with manufacturer's instructions.

3.05 PROTECTION

- A. Allow a minimum of 24 hours curing time before opening tennis courts for play.
- B. Protect applied asphalt tennis court surface color coating system to ensure that, except for normal weathering, coating system will be without damage or deterioration at time of Substantial Completion.

END OF SECTION

**SECTION 323100
CHAIN LINK FENCES**

PART 1 GENERAL

1.01 SUMMARY AND RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Refer to other sections of the specifications, drawings, and details to determine type and extent of work there is affecting the work of this section, whether or not such work is specifically mentioned in this section. It is the intent of this specification to include labor and material required to complete this section whether or not it is clearly or explicitly shown.
- C. Related Requirements:
 - 1. Section 321330 – “Concrete Paving”

1.02 DESCRIPTION OF WORK

- A. The Contractor shall provide all labor, materials, and appurtenances necessary for installation of gates and chain link with mesh fence to the dimensions and in the location as indicated on the drawings.

1.03 QUALITY ASSURANCE

- A. Comply with the standards of the Chain Link Fence manufacturer’s Institute, including (unless otherwise indicated):
 - 1. Specification for Metallic Coated Steel Chain Link Fence Fabric
 - 2. Industrial Steel Specifications for Fence Rails, Posts, and Accessories
 - 3. ASTM F-567 – Standard Practice for Installation of Chain Link Fence for installation unless otherwise indicated on the Contract Documents.
- B. Qualifications
 - 1. Provide metal fences as a complete unit produced by a single manufacturer, including necessary erection accessories, fitting, and fasteners. Products shall be provided by a single company specializing in commercial quality chain link fencing with at least five years’ experience.
- C. Regulatory Requirements
 - 1. Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in “Submittals-Quality Control Submittals” above.

1.04 REFERENCES

- A. Comply with ASTM A 53 for requirements of Schedule 40 piping.
- B. Chain Link Fence manufacturer Institute (CLFM) latest edition product manual.

1.05 DEFINITIONS

- A. Height of Fence: Distance measured from the top of the concrete footing to the top of the fabric.

1.06 SUBMITTALS

- A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.
- B. Product Data: Submit manufacturer’s name, specifications and installation instructions for each item specified.
- C. Shop Drawings: Complete detailed drawings for each height and style of fence required. Include separate schedule for each, listing all materials required and technical data such as size, weight and finish to ensure conformance to the specifications.
- D. Quality Control Submittals

1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the "Qualifications" requirements specified below in the "Quality Assurance" section of this specification.
 2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified in the "Quality Assurance" section of this specification.
- E. Closeout Procedures: Comply with the requirements of Section 017800.
- F. Samples:
1. Fence Fabric: Minimum one square foot, if requested.
 2. Fence Posts: Two each, one foot long, if requested.
 3. Miscellaneous Materials and Accessories: One each, if requested.

1.07 PROJECT CONDITIONS

- A. Field measurements: Establish and maintain required lines and elevations for grade control.

1.08 SEQUENCING AND SCHEDULING

- A. Proceed with and complete chain link fence and gate installation as rapidly as portions of the site become available, working within seasonal limitations for the work required.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Framework Standards
1. Steep Pipe: Cold rolled steel pipe meeting the requirements of ASTM F 1043 with a minimum yield strength of 50,000 psi.
 2. Interior Coating: In line applied zinc rich coating with zinc powder loading of a minimum 90% by weight applied after fabrication conforming to STM B 6 high grade and Special High Grade Zinc.
 3. Exterior Coatings
 - a. Base Coat: Minimum .9 ounces zinc per square foot.
 - b. Intermediate Coat: Minimum 15 microgram chromate conversion per square inch.
 - c. Top Coat: Minimum 0.3 mil cross link polyurethane acrylic exterior coating.
 - d. PVC exterior coating: Fusion bonded polyvinyl chloride similar to Brighton Colorbond Fence System by Merchant Metals, Brighton Michigan. Color to be black unless specifically noted otherwise on the Contract Documents.
 4. Size of Pipe: As indicated.
 5. Similar to SS-40 Pipe with Flo-Coat by Allied Tube and Conduit Corporation, Harvey, Illinois.
- B. Framework and Footings for Fences Up to 10'-0" High
1. End Posts, Corner Posts and Pull Posts
 - a. Pipe: 3.00" O.D.
 - b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
 - c. Footing Size: 12" O.D. by 5'-0" deep.
 2. Line Posts
 - a. Pipe: 2.50" O.D.
 - b. Space line posts at a minimum of 10 feet on center unless specifically noted otherwise on the contract documents.
 - c. Footing Size: 12" O.D. by 5'-0" deep.
- C. Framework and Footings for Double Leaf Gates Up to 10'-0" High with up to a 12'-0" Span

1. Gate Posts
 - a. Pipe: 4.00" O.D.
 - b. Footing Size: 14" O.D. by 3'-6" deep.
 - c. Assemble gate frames by welding. Install mid-height horizontal rails on gates over 10'-0" in height. When the width of a gate leaf exceeds 10'-0", install mid-distance vertical bracing of the same size and weight as frame members. When either horizontal or vertical bracing is not required, provide truss rods as cross bracing to prevent sag or twist.
- D. Swing Gate Hardware
 1. Hinges: Non-lift type, offset to permit 180 degree swing and of a suitable size and weight to support the gate. Provide 1 ½ pair of hinges for each leaf over 6" high.
 2. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
- E. Post Brace: Provide manufacturer's standard adjustable brace at gate posts and at both sides of corner and pull posts, with a horizontal brace located at the mid-height of the fabric.
- F. Top, Intermediate, and Bottom Rails: 1.66" O.D. pipe, weighing 1.84 pounds per linear foot. Install rails in the manufacturer's longest lengths utilizing expansion couplings, approximately 6" long at each joint. Provide means for attaching the top rail securely to each gate post, corner post, pull post and end post.
- G. Chain Link Fabric
 1. Aluminum Coated Fabric: Unless otherwise specified, provide 2" mesh, 9 gauge steel wires complying with ASM A-491, with one piece fabric widths for fencing up to 12 feet high. Fabric finish to be not less than 0.40 ounces of aluminum coating per square foot of wire surface for 11 through 14 gauge wire fabric in accordance with ASTM A-491.
 - a. PVC exterior coating: Fusion bonded polyvinyl chloride similar to Brighton Colorbond Fence System by Merchant Metals, Brighton Michigan. Color to be black unless specifically noted otherwise on the Contract Documents.
 2. Selvages: Top and bottom selvages to be knuckled unless specifically noted otherwise on the Contract Documents.
- H. Post Caps:
 1. Weather tight closure cap, one cap per post.
 2. Furnish caps with openings to permit passage of rail.
 3. Fasteners: Tamper resistant cadmium plated steel screws.
- I. Stretcher Bars: One piece equal to the full length of the fabric, minimum cross section 3/16" by 3/4".
- J. Metal Bands (for securing stretcher bars): Steel, wrought iron or malleable iron.
- K. Hardware: Self locking bands, tie wires and similar accessories. All hardware ends to pipe rails and other fence components must be of solid construction that prevents access to wasps and similar insects.
- L. Tension Wire: Manufacturer's standard 7 gauge coiled spring steel wire.
- M. Wire Tires:
 1. For tying fabric to line posts, rails, and braces: 9 gauge steel wire installed at 12" O.C.
 2. For tying tension wire to fabric: 11 gauge steel hog rings at 24" O.C.
- N. Truss Rods: 3/8" diameter.
- O. Bolts and Nuts: ASTM A 307, Grade A.
- P. Concrete: Portland cement concrete having a minimum compressive strength of 3000 psi at 28 days.
- Q. Existing Post Exterior Coating
 1. Primer:
 - a. Pro-Cryl Universal Primer B66-1300 Series

- 1) Manufactured by Sherwin-Williams
 - b. Base: Medium Gray
 - c. Finish: Low Sheen
- 2. Intermediate:
 - a. Waterbased Catalyzed Epoxy B73-300 Series
 - 1) Manufactured by Sherwin-Williams
 - b. Color: Tricorn Black
 - c. Base: Ultradeep Base
 - d. Finish: Gloss
- 3. Topcoat:
 - a. Waterbased Catalyzed Epoxy B73-300 Series
 - 1) Manufactured by Sherwin-Williams
 - b. Color: Tricorn Black
 - c. Base: Ultra Deep Base
 - d. Finish: Gloss

PART 3 EXECUTION

3.01 EXAMINATION

- A. Installer Verification of Conditions: Examine conditions under which chain link fences and gates are to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
 - 1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

- A. Clear and grab plant material along the fence line as required to eliminate growth interfacing with the fence alignment. Remove all debris from the project property.
- B. Do not begin installation of the fence until finish grading in area has been completed.

3.03 INSTALLATION

- A. Space posts established in the fence line at a maximum of 10 feet on center unless specifically noted otherwise on the Contracted Documents.
- B. Setting Post in Earth: Drill holes for fence footings. Set posts in the center of the hole and fill the hole with concrete. Plumb and align posts, vibrate or tamp concrete for consolidation. Finish concrete in a dome shape above the finish grade elevation to shed water. Do not attach fabric to posts until the concrete has cured a minimum of seven days.
- C. Located corner posts and at changes in direction. Use pull posts at all abrupt changes in grade and at intervals between corner or end posts. On long curves, space pull posts so that the strain of the fence will not bend line posts.
- D. Install top rail continuously through post tops or extension arms, bending to radius for curved runs. Install expansion couplings as recommended by the fencing manufacturer.
- E. Install bottom and intermediate rails in one piece between posts and flush with the post on the fabric side using special offset fittings where necessary.
- F. Brace corner posts, pull posts, end posts and gate posts to adjacent line posts with horizontal rails.
- G. Diagonally brace corner posts, pull posts, end posts and gate posts to adjacent line posts with truss rods and turnbuckles.

- H. Attach the fabric to the active playfield or security side of the fence. Maintain a 1 inch clearance above the finished grade except where indicated otherwise. Thread stretcher bars through the fabric using one bar for each gate and end post and two for each corner and pull post. Pull fabric tight so that the maximum deflection of the fabric is 2 inches when a 30 pound pull is exerted perpendicular to the center of a panel.
 - 1. Maintain tension by securing stretcher bars to posts with metal bands spaced at 15" O.C.
 - 2. Fasten fabric to steel framework with wire ties spaced 12" O.C. for line posts and 24" O.C. for rails and braces. Bend back wire ends to prevent injury.
 - 3. Tighten stretcher bar bands, wire ties and other fasteners securely.
 - 4. When the fabric height exceeds 12", overlap horizontal splices 6" at the intermediate rail and secure with wire ties spaced at 12" O.C.
- I. Position bolts for securing metal bands and hardware so nuts are located opposite the fabric side of the fence. Tighten nuts and cut off excess threads so no more than 1/8" is exposed. Peen ends to prevent loosening or removal of nuts. Secure post tops and extension arms with tamper resistant screws.
- J. Wire brush and repair welded and abraded areas with one coat of cold galvanizing compound.
- K. Restore disturbed ground areas to their original condition. Topsoil and seed to match adjacent areas.

3.04 ADJUSTING AND CLEANING

- A. Repairs and Protection of chain link fences and gates.
 - 1. Repair or replace broken or defective chain link fences as directed by the Project Designer.
 - 2. Protect chain link fences and gates from damage until acceptance of the fencing construction.

END OF SECTION

SECTION 325500
RESTORATION OF DISTURBED SURFACES

PART 1 GENERAL

1.01 SUMMARY AND RELATED REQUIREMENTS

- A. This section includes, but is not limited to the following:
- B. Restoring areas disturbed by Contractor's Work.
- C. Provide all labor, materials, equipment and services required for the restoration of all disturbed surfaces, including, but not necessarily limited to: sidewalks, curbs and driveways; lawns, trees, and other landscape materials; signs, poles, and fences. Wherever grading or excavation takes place the area shall receive topsoil and grass seed as per Section 329000 "Landscape Work" unless otherwise noted.
- D. The Contractor shall leave site in an equal or better condition than it exists prior to construction.
- E. Related Requirements:
 - 1. Section 312000 – "Earth Moving"
 - 2. Section 329113 – "Soil Preparation"
 - 3. Section 329118 – "Landscape Grading"
 - 4. Section 329219 – "Seeding"

1.02 QUALITY ASSURANCE

- A. Perform work of this Section in strict compliance with local requirements.
- B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of work specified in this Section.
- C. Use equipment adequate in size, capacity, and numbers to accomplish work in a timely manner.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform all work in a neat workmanlike manner.

3.02 ADJUST AND CLEAN

- A. The Contractor is responsible for correction of all work which does not conform to the specified requirements, including, strength, tolerances, dimensions, and finishes.
- B. Upon completion of work, remove from site all rubbish, trash, and other debris resulting from operations. Remove all equipment and implements of service. Leave entire area in neat, clean, and acceptable conditions, ready for subsequent operations.

END OF SECTION

SECTION 329113
SOIL PREPARATION

PART 1 GENERAL

1.01 SUMMARY AND RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This Section includes soil and soil amendment products, including all imported soil and soil mixes. Execute all labor to achieve soil preparation, complete, as shown and as specified.
- C. The following references are used herein:
 - 1. ASTM: American Society of Testing Materials.
 - 2. USDA: United States Department of Agriculture.
 - 3. AASHTO: American Association of State Highway and Transportation Officials.
 - 4. "Standard Specifications" - Standard Specifications of the New York State Department of Transportation.
 - 5. AOAC: Association of Official Agricultural Chemists.
- D. Related Requirements:
 - 1. Section 312000 – "Earth Moving"

1.02 DEFINITIONS

- A. Existing Soil: Area of undisturbed native soil where no rough grading is to be performed. Surface cultivation and soil amending are included in this Section. See Drawings.
- B. Subgrade: Soil level resulting from the rough grading work under another Section. Cultivation of all subgrade areas prior to placement of topsoil is included in this Section.
- C. Topsoil: Soil stockpiled for spreading over prepared subgrade.
 - 1. Imported Topsoil: Offsite topsoil imported and stockpiled under this Section, to be spread and amended as work under this Section.
- D. Structural Soil: Material designed to function as a sub-base material under pavements for pedestrian traffic or light vehicular traffic with the ability to withstand loading of emergency and/or maintenance vehicles. Its intended purpose is for establishing trees in areas where tree is totally surrounded by pavement.
- E. Import Soil: Amended imported soil or imported sand that has been amended per recommendations of agricultural suitability testing.

1.03 SAMPLES AND SUBMITTALS

- A. At least 30 days prior to ordering materials the Contractor shall submit to the Architect representative samples, certificates, manufacturer's literature and certified tests for materials specified below. No materials shall be ordered until the required samples, certificates, manufacturer's literature and test results have been reviewed and approved by the Architect. Delivered materials shall closely match the approved samples. Approval shall not constitute final acceptance. Architect reserves the right to reject, on or after delivery, any material that does not meet these specifications.
- B. Samples:
 - 1. Submit two – one-half cubic foot representative samples of Clay Loam and two – two cubic foot representative samples Structural Soil mixes for testing, analysis and approval. Submit one set of samples for every 500 cubic yards of material to be delivered. In the event of multiple source fields for Clay Loam, submit a minimum of one set of samples per source field or stockpile. Samples shall be taken randomly throughout the field or stockpile at locations as directed by the Architect and packaged in the presence of the Architect. Contractor shall deliver all samples to testing agency and shall have test results sent directly to Architect. Samples shall be labeled to

include the location of the source of the material, the date of collection and the Contractors name. One of the two samples is to be used by the testing laboratory for testing purposes. The second sample of all Clay Loam and Structural Soil shall be submitted to the Architect at the same time as test analysis results as a record of the soil color and texture.

- a. Submit the location(s) of all source fields for Clay Loam.
 - b. Submit a list of all chemicals and herbicides applied to the Clay Loam for the last five years and a list of all crops grown in the Clay Loam source fields for the last three years.
2. Submit soils test analysis reports for each sample of Clay Loam and Structural Soil from an approved soil testing laboratory. The test results shall report the following:
- a. The soil testing laboratory shall be approved by the Architect. The testing laboratory for particle size and chemical analysis may be a public agricultural extension service agency or agricultural experiment station.
 - b. Submit bulk density of the sample and particle size analysis including the following gradient of mineral content:

<u>USDA Designation</u>	<u>Size in mm.</u>
Gravel	+ 2
Sand	0.05 - 2
Silt	0.002 - 0.05
Clay	Minus 0.002

Sieve analysis shall be performed and compared to USDA Soil Classification System. Sieve analysis shall be done by a combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in compliance with ASTM D422 after destruction of organic matter by hydrogen peroxide.

- c. Submit chemical analysis, performed in accordance with current AOAC Standards, including the following:
 - 1) PH and Buffer pH
 - 2) Percent organic matter as determined by the loss of ignition of oven dried samples. Test samples shall be oven dried to a constant weight at a temperature of 230 degrees F, plus or minus 9 degrees.
 - 3) Analysis for nutrient levels by parts per million including nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, magnesium, manganese, iron, zinc, calcium and extractable aluminum. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil as calculated by the amount of materials to be added per volume of soil for the type of plants to be grown in the soil.
 - 4) Analysis for levels of toxic elements and compounds including arsenic, boron, cadmium, chromium, copper, lead mercury, molybdenum, nickel, zinc and PCB. Test results shall be cited in milligrams per kilogram.
 - 5) Soluble salt by electrical conductivity of a 1:2 soil/water sample measured in Millimho per cm.
 - 6) Cation Exchange Capacity
 - 7) Carbon/Nitrogen Ratio.
- d. Submit 5-point minimum moisture density curve AASHTO T 99 test results for each Structural Soil sample without removing oversized aggregate.
- e. Submit Missouri Bearing Ratio test results for each Structural Soil sample compacted to peak standard density. The soaked CBR shall equal or exceed a value of 50.
- f. Submit measured dry-weight percentage of stone in the mixture.
- g. The approved Structural Soil samples shall be the standard for each lot of 500 cubic yards of material.

- h. All testing and analysis shall be at the expense of the Contractor.
- 3. Submit to the Architect for review a proposed plan and vertical section layout of all Structural Soil.
- 4. Submit one cubic foot sample per each 500 cubic yards of required material, and for each sample, the following analysis for all Crushed Stone. The soil testing laboratory shall be approved by the Architect.
 - a. Provide a particle size analysis including the following gradient of mineral content:

<u>USDA Designation</u>	<u>Size in mm.</u>
3@	+76
2-1/2@	63 - 76
2@	50 - 63
1-1/2	37 - 50
1@	25 - 37
3/4@	19 - 25
Fine Gravel	2 - 19
Sand	0.05 - 2
Silt	0.002 - 0.05
Clay	Minus 0.002

- b. Provide manufacturers analysis of the following:
 - 1) Loose and rodded unit weight
 - 2) Bulk specific gravity and absorbency
 - 3) Stone dimension and surface texture description
 - 4) Documentation of acceptance for use as CALTRANS approved aggregate.
 - c. Provide a percent pore space analysis defined as follows:
 - 1) 1 minus Rodded Unit Weight divided by the Bulk Specific Gravity times 100.
 - 5. Submit one-pound sample of each type of fertilizer and three certificates showing composition and analysis. Submit the purchasing receipt for each fertilizer showing total quantity purchased for the project prior to installation.
 - 6. Submit Test Reports:
 - a. Existing soil: Test for agricultural suitability, parasitic nematodes and herbicide contamination. Report to include amendment recommendations.
 - b. Imported Topsoil: Test for agricultural suitability, parasitic nematodes and herbicide contamination. Report to include amendment recommendations to meet or exceed amended existing soil.
 - c. Nitrogen-treated Sawdust: Test for physical and chemical properties.
 - 7. Certificates: Certify strict compliance with accepted soil mixes and amendments, including rate of application.
- C. Product Data: Manufacturer's current catalog cuts and specifications of the following:
 - 1. Fertilizer
 - 2. Nitrogen-treated sawdust
 - 3. Peat moss
 - 4. Herbicide
 - 5. Filter Fabric

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver or place soils in wet or muddy conditions. Material shall be delivered at or near optimum compaction moisture content as determined by AASHTO T 99 (ASTM D 698). Do not deliver

or place materials in an excessively moist condition (beyond 2 percent above optimum compaction moisture content as determined by AASHTO T 99 (ASTM D 698).

- B. Protect soils and mixes from absorbing excess water and from erosion at all times. Do not store materials unprotected from large rainfall events. Do not allow excess water to enter site prior to compaction. If water is introduced into the material after grading, allow material to drain or aerate to optimum compaction moisture content.

1.05 SEQUENCING AND SCHEDULING

- A. All areas to receive prepared soils shall be inspected by the Contractor before starting work and all defects such as incorrect grading, compaction and inadequate drainage etc. shall be reported to the Architect in writing.
- B. Contractor shall be responsible for judging the full extent of work requirements involved, including but not limited to the potential need for temporary storage and staging of soils, including moving soil stock piles at the site to accommodate scheduling of other work and the need to protect installed soils from compaction, erosion and contamination.
- C. Do not install on-structure drainage materials and soil mix prior to acceptance of waterproofing in another section.

1.06 QUALITY ASSURANCE

- A. Qualifications of Landscape or Pavement Material Contractor: The work of this section shall be performed by a Contracting firm which has a minimum of five years experience successfully installing prepared soils of similar quality, schedule requirements and construction detailing to this project. Proof of experience shall be submitted as per article, SAMPLES AND SUBMITTALS, of this Section.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Clay Loam:
 - 1. Clay Loam shall be a "loam" based on the "USDA classification system" as determined by mechanical analysis (ASTM D-422) and it shall be of uniform composition, without admixture of subsoil. It shall be free of stones greater than one-half inch, lumps, plants and their roots, debris and other extraneous matter over one inch in diameter or excess of smaller pieces of the same materials as determined by the engineer. It shall not contain toxic substances harmful to plant growth. It shall be obtained from naturally well-drained areas, which have never been stripped of topsoil before and have a history of satisfactory vegetative growth. Clay Loam shall contain not less than 2% nor more than 5% organic matter as determined by the loss on ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 230 degrees F., plus or minus 9 degrees.
 - 2. Mechanical analysis for a Loam/Clay Loam shall be as follows:

<u>Textural Class</u>	<u>% of Total Weight</u>
Gravel	less than 5%
Sand	20 – 45%
Silt	20 – 50%
Clay	20 – 40%

- 3. Chemical Analysis: Meet or be amended to meet the following criteria.
 - a. pH between 5.5 to 6.5
 - b. Percent organic matter 2 – 5% by dry weight.
 - c. Nutrient levels as required by the testing laboratory recommendations for the type of plants to be grown in the soil.

- d. Toxic elements and compounds below the United States Environmental Protection Agency Standards for Exceptional Quality sludge or local standard; whichever is more stringent.
 - e. Soluble salt less than 1.0 Millimho per cm.
 - f. Cation Exchange Capacity (CEC) greater than 10
 - g. Carbon/Nitrogen Ratio less than 33:1.
4. Clay Loam shall be the product of a commercial processing facility specializing in production of stripped natural topsoil. No topsoil shall come from USDA – classified prime farmland.
- B. Fertilizer:
- 1. Commercial fertilizer complying with State and Federal fertilizer laws. Deliver fertilizer in original unopened containers, which shall bear the manufacturer’s certificate of compliance covering analysis, which shall be furnished to the Architect. Fertilizer shall be formulated for mixing into the soil and be certified by the manufacturer to provide controlled release of nitrogen continuously for a period of no less than nine months and no more than twelve months.
 - 2. Fertilizer percentages of weight of ingredients and application rates shall be as recommended by the soil testing results.
- C. Sulfur (as required):
- 1. Sulfur shall be commercial granular, 96% pure sulfur, delivered in containers with the name of the manufacturer, material and analysis appearing in the container.
 - 2. Sulfur used to lower soil pH above 6.5 shall be ferrous sulfate formulation.
- D. Lime (if needed): Agricultural limestone containing a minimum of 85% carbonates. Minimum gradation: 100% passing 10 mesh sieve; 98% passing 20 mesh sieve; 55% passing 60 mesh sieve and 40% passing 100 mesh sieve.
- E. Crushed Stone:
- 1. Crushed Stone shall be a DOT certified crushed stone. Granite and limestone have been successfully used in this application. 90 – 100 percent of the stone should pass the 1.5 inch sieve, 20 – 55 percent should pass the 1 inch sieve and 10 percent should pass the .75 inch sieve. A ratio of nominal maximum to nominal minimum particle size of 2 is required.
 - 2. Acceptable aggregate dimensions will not exceed 2.5:1 for any two dimensions chosen.
 - 3. Minimum 90 percent with one fractured face, minimum 75 percent with two or more fractured faces.
 - 4. Results of Aggregate Soundness Loss test shall not exceed 18 percent.
 - 5. Losses from LA Abrasion tests shall not exceed 40%.
- F. Hydrogel: Hydrogel shall be potassium propenoate-propenamamide copolymer Hydrogel as manufactured by Gelscape by Amereq Corporation, (800) 832-8788.
- G. Water: Clean and potable, provided by Owner.
- H. Structural Soil
- 1. A uniformly blended mixture of Crushed Stone, Clay Loam and Hydrogel, mixed to the following proportion:

<u>Material</u>	<u>Unit of Weight</u>
Crushed Stone	100 units dry weight
Clay Loam	as determined by the test of the mix (approx. 20 units)
Hydrogel	0.03 units dry weight
Total Moisture.	AASHTO T-99 optimum moisture
 - 2. The initial mix design for testing shall be determined by adjusting the ratio between Crushed Rock and the Clay Loam. Adjust final mix dry weight mixing proportion to decrease soil in mixture if CBR test results fail to meet acceptance (CBR#50)

3. Mix Design: Prepare sample Structural Soil mixes to determine the ratio of mix components. Submit for approval as follows:
 - a. Submit samples and the test results of each mix components for approval. Based on samples and the analysis of the mix components, the Architect and the Contractor will jointly determine a mix ratio to be tested for conformance with the requirements of the specifications. For Structural Soil quantities greater than 500 cubic yards, test the mix ratio for each Clay Loam or Crushed Stone as determined by the Architect.
 - b. The Contractor shall prepare the samples of the proposed mix ratio options and obtain soil test as described in Part 1 of this Section. Submit the samples of each of the mixes with the test results.
 - c. The Architect may request additional Structural Soil mix ratio samples to be tested in the event that further refinement of the mix is necessary.
 - d. Submit to the Architect proposed fertility amendment recommendations including amounts and types of fertilizers and pH adjustments for each mix ratio. Fertility adjustments shall be included as part of the mixing process.
4. Soil Mixing:
 - a. All structural Soil mixing shall be performed off site using appropriate soil measuring, mixing and shredding equipment of sufficient capacity and capability to assure proper quality control and consistent mix ratios.
 - b. Maintain adequate moisture content during the mixing process. Soils and mix components shall easily shred and break down without clumping. Soil clods shall easily break down into a fine crumbly texture. Soils shall not be overly wet or dry. The Contractor shall measure and monitor the amount of soil moisture at the mixing site periodically during the mixing process.
 - c. Mixing method to be by pugging operation unless otherwise approved by Architect in writing.
 - d. Add soil amendments to alter soil fertility including fertilizers and pH adjustment at the time of mixing at the rates recommended by the soil test.
 - 1) Soil pH shall be adjusted to fall within a value of 5.5 and 6.5 two months after mixing if the material is stored, unless mixing with high pH stone. Once pavement is laid, no adjustment should be imposed.
 - 2) Soil component Carbon/nitrogen ratio shall be adjusted to be less than 33:1 within two months after mixing.
 - e. The Contractor shall mix sufficient material in advance of the time needed at the job site to allow adequate time for final quality control testing as required by the progress of the work. If quantity of Structural Soil required exceeds 500 cubic yards, mixed soil shall be stored in piles of approximately 500 cubic yards and each pile shall be numbered for identification and quality control purposes.
 - f. During mixing process, the Contractor shall take two – one cubic foot quality control samples per 500 cubic yards of production from the final Structural Soil. The samples shall be taken from random locations in the numbered stockpiles. Each sample shall be tested for particle size analysis and chemical analysis as described in Part 1 of this Section. Submit the results directly to the Architect for review and approval.
 - g. The quality control sample Clay Loam-Crushed Stone ratio's shall be no greater or less than 2% of the approved test sample as determined by splitting a known weight of oven dried material on a #4 sieve. In the event that the quality control samples vary significantly from the approved Structural Soil sample as determined by the Architect, remix and retest any lot of soil that fails to meet the correct analysis making adjustments to the mixing ratios and procedures to achieve the approved consistency.

2.02 ACCESSORIES

- A. Fine Sand:
 1. Physical Properties (by dry weight basis):

<u>Percent Passing</u>	<u>Sieve Size</u>
100	4.76 mm(#4, 4 mesh)
95 - 100	1.00 mm (#18, 16 mesh)
65 - 100	500 micron (#35, 32 mesh)
0 - 50	250 micron (#60, 60 mesh)
0 - 20	105 micron (#140, 150 mesh)
0 - 5	53 micron (#270, 270 mesh)

2. Chemical Properties: (by Saturation Extract Method):
 3. Soluble Salts/Salinity: Maximum conductivity of 3.0 millimhos/cm at 25 degrees C.
 4. Boron: Maximum concentration of 1.0 ppm.
 5. Sodium Absorption Ratio (SAR): Maximum 6.0.
- B. Water: Clean, fresh and potable, as available from Owner. Transport as required.
- C. Perforated Drain Pipe: See Division 33, Section "Landscape Drainage".
- D. Drain Rock: See Division 33, Section "Landscape Drainage".

2.03 ORGANIC COMPONENTS

- A. Peat Moss:
1. Type: Finely-shredded, brown in color, suitable for horticultural purposes and frequently referred to in the trade as "greenhouse" or "coarse grind".
 2. Measurement: Measure peat in air dry condition, containing not more than 35% moisture by weight on an "as-received" basis. Ash content shall not exceed 10%.
 3. Physical Properties:

<u>Percent Passing</u>	<u>Sieve Size</u>
95 - 100	9.51 mm (3/8 in.)
0 - 40	500 micron (#35, 32 mesh)

4. Organic Content (dry weight basis): 90-100%
 5. Chemical Properties:
 - a. Nitrogen (dry weight basis): 0.6-3.0%
 - b. Salinity/Soluble Salts: Saturation extract conductivity 0.0-3.0 millimhos/cm @ 25 degrees C.
 - c. pH: 3.0-4.5
 6. Acceptable Substitute: Ground redwood bark, per specifications for peat moss.
- B. Nitrogen-Treated Sawdust:
1. Type: Derived from redwood, fir or cedar wood sawdust.
 2. Physical Properties:

<u>Percent Passing</u>	<u>Sieve Size</u>
95 - 100	6.35 mm. (1/4 in.)
80 - 100	2.38 mm. (#8, 8 mesh)
0 - 30	500 micron (#35, 32 mesh)

3. Chemical Properties:
 - a. Nitrogen content (dry weight basis):
 - 1) Wood of Redwood 0.4 - 0.6%
 - 2) Wood of Fir/Cedar 0.56 - 0.84%
 - b. Iron content (dry weight basis): 0.08% iron as metallic, minimum.

- c. Salinity/Soluble salts: Maximum 3.5 millimhos/cm 25 degrees C. as determined by saturation extract method.
 - d. Ash (dry weight basis): 0 - 6.0 percent maximum.
- C. Treated Fir/Pine Bark:
- 1. Physical Properties (dry weight basis):

<u>Percent Passing</u>	<u>Sieve Size</u>
95 - 100	6.35 mm (1/4 in.)
80 - 100	2.38 mm (#8, 8 mesh)
0 - 30	500 micron (#35, 32 mesh)
 - 2. Organic Content (dry weight basis): 94 percent minimum as determined by ash analysis.
 - 3. Chemical Properties:
 - a. Nitrogen Content (dry weight basis): 0.8 percent minimum.
 - b. Soluble Salts/Salinity: Maximum Saturation Extract Conductivity 3.0 millimhos/cm at 25 degrees C, by method.
 - c. Iron (dry weight basis): 0.08 percent minimum.
 - d. pH: 6.5 - 7.5
 - 4. Wettability:
 - a. When applied to a cup or small beaker of water @ 70 degrees F. in the amount of 1 teaspoon, the air-dry product shall become completely wet in a period not exceeding 2 minutes.
 - b. All wetting agents to be non-phytotoxic at rate used.

2.04 CHEMICAL COMPONENTS

- A. The following additives may or may not be used depending on the outcome of the soils report.
 - 1. Ground Limestone: Agricultural limestone containing not less than 85% of total carbonates, ground to such fineness that 50% will pass #100 sieve and 90% will pass #20 sieve.
 - 2. Dolomite Lime: Agricultural grade mineral soil conditioner containing 35% minimum magnesium carbonate and 49% minimum calcium carbonate, 100% passing #65 sieve.
 - 3. Gypsum: Agricultural grade product containing 80% minimum calcium sulphate.
 - 4. Iron Sulfate (Ferric or Ferrous): Supplied by a commercial fertilizer supplier, containing 20% to 30% iron and 35% to 40% sulphur.
 - 5. Sulphate of Potash: Agricultural grade containing 50% to 53% of water-soluble potash.
 - 6. Single Superphosphate: Commercial product containing 20% to 25% available phosphoric acid.
 - 7. Ammonium Sulphate: Commercial product containing approximately 21% ammonia.
 - 8. Ammonium Nitrate: Commercial product containing approximately 34% ammonia.
 - 9. Calcium Nitrate: Agricultural grade containing 15-1/2% nitrogen.
 - 10. Urea Formaldehyde: Granular commercial product containing 38% nitrogen.
 - 11. I.B.D.U. (Iso Butyldiene Diurea): Commercial product containing 31% nitrogen.
 - 12. Soil Sulfur: Agricultural grade sulfur containing a minimum of 96% sulfur.

PART 3 EXECUTION

3.01 SOIL MOISTURE CONTENT

- A. General: Do not work soil when moisture content is so great that excessive compaction will occur, nor when it is so dry that dust will form in air or that clods will not break readily. Apply water, if necessary, to bring soil to an optimum moisture content for tilling and planting.
- B. Range: Maintain within 2 percent above or below optimum moisture content at all times during the work.

3.02 BLENDING OF SOIL MIXES

- A. Structural Soil:
 - 1. Mix Design
- B. Site Soil Mix:
 - 1. Blending: Thoroughly bulk-blend materials uniformly in stockpiles.
 - 2. Testing: Retain a Testing Agency to certify conformance of materials to Specifications and to prepare one laboratory control sample of planting soil mix in accordance with the Specifications.

3.03 INSTALLATION OF STRUCTURAL SOIL MATERIAL

- A. Do not proceed with the installation of the Structural Soil material until all curbs and utility work in the area have been installed. For site elements dependent on Structural Soil for foundation support, postpone installation until immediately after installation of Structural Soils.
- B. Install subsurface drain lines as shown on the Drawings prior to installation of Structural Soil material.
- C. Excavate and compact proposed subgrade to depths, slopes and widths as shown on the Drawings. Confirm that subgrade elevations slope parallel to the finished grade and or toward the subsurface drain lines as shown on the Drawings. See also Division 31 Section "Earth Moving".
- D. Clear the excavation of all construction debris, trash, rubble and any foreign material. In the event that fuels, oils, concrete washout silts or other materials harmful to plants have been spilled into the subgrade material, excavate the soil sufficiently to remove the harmful material. Fill any over excavation with approved fill and compact to required subgrade compaction.
- E. Protect adjacent improvements and utilities from damage or staining by the soil. Use 1/2" plywood and or plastic sheeting as directed to cover existing improvements subject to staining. Clean any soil spilled onto adjacent improvements at the end of each working day. The Contractor at no additional cost to the Owner shall repair any damage to adjacent improvements caused by soil installation.
- F. Provide adequate methods to assure that trucks and other equipment do not track soil from the site onto adjacent property and the public right of way.
- G. Install Structural Soil in six-inch lifts and compact each lift.
- H. Compact all materials to peak dry density from a standard AASHTO compaction curve (AASHTO T 99). No compaction shall occur when moisture content exceeds maximum as listed herein. Delay compaction 24 hours if moisture content exceeds maximum allowable and protect Structural Soil during delays in compaction with plastic or plywood as directed by Architect.
- I. Bring Structural Soils to finished grade as shown on the Drawings. Immediately protect the structural Soils material from contamination by toxic materials, trash, debris, water containing cement, clay silt or materials that will alter the particle size distribution of the mix with plastic or plywood as directed by the Architect.
- J. The Architect may periodically check the material being delivered and installed at the site for color and texture consistency with the approved sample provided by the Contractor as part of the submittal for Structural Soil/

3.04 FIELD QUALITY CONTROL

- A. Tests: Right is reserved to take samples of prepared soils for testing for conformity to Specifications.
- B. Rejected Materials: Remove off site at Contractor's cost. Pay cost of testing of materials, not meeting Specifications.

END OF SECTION

**SECTION 329118
LANDSCAPE GRADING**

PART 1 GENERAL

1.01 SUMMARY AND RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.
- B. Work Included: Execute finish grades complete, as shown, and as specified.
- C. Unit Pricing: Per square foot.
- D. Related Requirements:
 - 1. Section 312000 – “Earth Moving”

1.02 PROJECT/SITE CONDITIONS

- A. Existing Conditions: Verify that rough grading work is complete prior to commencement of finish grade scope.
- B. Dust Nuisance: Assume full responsibility for alleviation or prevention of dust as a result of grading work.

1.03 SEQUENCING AND SCHEDULING:

- A. Complete all Soil Preparation – Section 329113 prior to finish grading.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Verify that the following items have been completed prior to commencement of finish grading:
 - 1. Installation of topsoil (stockpiled and imported) and soil preparation including debris removal.
 - 2. Incorporation of soil amendments.

3.02 INSTALLATION

- A. Finish Grading:
 - 1. Provide all grades for natural runoff of water without low spots or pockets. Accurately set flow line grades at 2 percent minimum gradient unless otherwise noted in Drawings.
 - 2. Finish grades shall be smooth, even and on a uniform plane with no abrupt changes of surface. Slope uniformly between given spot elevations.
 - 3. Grades not otherwise indicated shall be uniform levels or slopes between points where elevations are given, or between points established by walks, paving, curbs or catch basins.
 - 4. Tops and toes of all slopes shall be rounded to produce a gradual and natural-appearing transition between relatively level areas and slopes.

3.03 TOLERANCES:

- A. All planting areas, including lawn areas, shall be true to grade within 1 in. when tested with a 10 ft. straightedge.
- B. Hold finished grades below surface of adjacent pavement, headers, curbs, or walls as follows:
 - 1. Shrub, Annual and Groundcover Areas: 1-1/2 inches.
 - 2. Seeded Lawn Areas: 1 inch.

3.04 REVIEW AND ACCEPTANCE

- A. Once finish grading is complete, Landscape Architect to review and verify. Review is to occur prior to installation of plant material.

END OF SECTION

SECTION 329219

SEEDING

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data; Hydro Mulch: Manufacturer's specifications and application rate.
- B. Product Data; Erosion Control Blanket: Manufacturer's specifications.

1.02 QUALITY ASSURANCE

- A. Field Examples: Seed samples will be taken by the Director's Representative 30 days before sowing and sent to the New York State Seed Testing Laboratory, 6 Harriman Campus Road, Albany, NY 12206 for testing. Test analysis will indicate species, purity, percent of germination, and weed content. Results will be sent directly to the Director for acceptance or rejection based on these tests. Pay all expenses incurred for testing.

1.03 DELIVERY STORAGE AND HANDLING

- A. Deliver fertilizer in manufacturer's standard size bags or cartons showing weight, analysis, and the name of the manufacturer. Store as approved by Director's Representative.
- B. Store all seed at the site in a cool dry place as approved by the Director's Representative. Replace any seed damaged during storage.
- C. Deliver seeds, 30 days in advance of anticipated use, in vendor's unopened packages bearing labels showing vendor's name and seed analysis by weight.
- D. Deliver erosion control blanket in manufacturer's standard packing material, showing the name of the manufacturer. Store as approved by the Director's Representative.

1.04 SCHEDULING

- A. Time For Seeding: Optimum period to sow permanent grass seed is generally between April 1st and May 15th or between August 15th and October 1st. Schedule application for when weather conditions permit or as Directed.
 - 1. Provide temporary seed and mulch when final grading is complete while waiting for optimal seeding period.
 - 2. Provide temporary seed and mulch for temporary cover on disturbed ground not to be worked on for more than 7 days.
 - 3. Provide temporary seed and mulch on disturbed earth prior to temporary shutdown of construction.

PART 2 PRODUCTS

2.01 FERTILIZER

- A. Fertilizer: Mixed commercial fertilizers shall contain total nitrogen, available phosphoric acid and soluble potash in the ratio of 10-6-4 (50% N/UF). 50% of total nitrogen shall be derived from ureaform furnishing a minimum of 3.5% water insoluble nitrogen (3.5% WIN). The balance of the nitrogen shall be present as methylene urea, water soluble urea, nitrate and ammoniacal compounds.
- B. Other fertilizers meeting DOT Specification Section 713-03 Fertilizer can be used.

2.02 SEED

- A. Furnish fresh, clean, new-crop seed mixed in the proportions specified for species and variety and conforming to Federal and State Standards.
- B. Acceptable material in a seed mixture other than pure live seed consists of nonviable seed, chaff, hulls, live seed of crop plants and inert matter. The percentage of weed seed shall not exceed 0.1 percent by weight.

- C. All seed will be rejected if the label or test analysis indicates any of the following contaminates: Timothy, Orchard Grass, Sheep Fescue, Meadow Fescue, Canada Blue Grass, Alta Fescue, Kentucky 31 Fescue, and Bent Grass.
- D. Provide the following seed mixtures:
 - 1. ERNMX-126
 - 2. ERNMX-127
 - 3. *Lolium perenne* – Perennial Ryegrass

2.03 MULCH

- A. Dry Application, Straw: Stalks of oats, wheat, rye or other approved crops which are free of noxious weeds. Weight shall be based on a 15 percent moisture content.
- B. Hydro Application: Colored wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch. Acceptable Product: Conwed Hydro Mulch, Conwed Fibers, 231 4th Street SW, Hickory, NC.

2.04 EROSION CONTROL BLANKET

- A. Erosion Control Blanket: Product - SC150 by North American Green, 14649 Highway 41 North, Evansville, IN 47725, (800) 772-2040, www.nagreen.com.
 - 1. Stakes: North American Green (6" wire staples).

PART 3 EXECUTION

3.01 PREPARATION

- A. Seed Bed: Scarify soil to a depth of 3 inches in compacted areas. Smooth out unsightly variations, bumps, ridges, and depressions which will hold water. Remove stones, litter, or other objectionable material.
 - 1. Obtain written approval of seed bed from the Director's Representative before commencing seeding operations.

3.02 FERTILIZING

- A. Apply 10-6-4 fertilizer evenly at the rate of 40 pounds per 1000 sq ft or 2 pounds of nitrogen per 1000 sq ft.

3.03 SEEDING

- A. Assume all risks when seed is sowed before approval of seed analysis.
- B. Do not seed when the wind velocity exceeds 5 miles per hour.
- C. Application Rate:
 - 1. Seed Mix "B": 5 pounds per 1,000 sq. ft.
- D. Dry Application: Sow seed evenly by hand or seed spreader on dry or moderately dry soil.
- E. Hydroseeding:
 - 1. Apply seeding materials with an approved hydroseeder.
 - 2. Fill tank with water and agitate while adding seeding materials. Use sufficient fertilizer, mulch, and seed to obtain the specified application rate. Add seed to the tank after the fertilizer and mulch have been added. Maintain constant agitation to keep contents in homogeneous suspension. Prolonged delays in application or agitation that may be injurious to the seed will be the basis of rejection of material remaining in tank.
 - 3. Distribute uniformly a slurry mixture of water, seed, fertilizer, and mulch at a minimum rate of 57 gallons per 1000 sq ft (2500 gallons per acre). The Director's Representative may order the amount of water increased if distribution of seeding materials is not uniform.

3.04 MULCHING

- A. Dry Application: Within one day after seeding, cover the seeded areas with a uniform blanket of straw mulch at the rate of 100 pounds per 1000 sq ft of seeded area.

- B. Hydro Application: Apply approved mulch in accordance with the manufacturer's written instructions and recommended rates of application.

3.05 EROSION CONTROL BLANKET

- A. Erosion Control Blanket: Within one day after seeding, cover sloped areas with a uniform blanket of erosion control blanket. Apply approved blanket in accordance with the manufacturer's written instructions. Do not apply straw mulch in area that erosion control blanket will be covering.
 - 1. Stakes: Install approved stakes in accordance with the manufacturer's written instructions.

3.06 LAWN ESTABLISHMENT

- A. Maintain the grass at heights between 3 inches and 3-1/2 inches on a weekly basis until the Final Acceptance of the Work.
- B. Water and protect all seeded areas until final acceptance of the lawn.

3.07 FINAL ACCEPTANCE

- A. Final acceptance of lawn areas will be granted when a uniform stand of acceptable grass is obtained, with a minimum of 95 percent coverage. Portions of the lawn areas may be accepted at various times at the discretion of the Director's Representative.
- B. Unacceptable lawn areas, dry application: Reseed as specified and fertilized at one-half the specified rate.
- C. Unacceptable lawn areas, hydro application: Reseed, fertilize, and mulch at one-half the specified rate, use full water rate.
- D. At the physical completion of the Work, the State will assume maintenance responsibilities of the lawn areas.

END OF SECTION

SECTION 333913

DRAINAGE STRUCTURES WITH FRAMES AND COVERS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Earthwork: Section 310000.
- B. Corrugated Polyethylene Storm Drain Pipe: Section 334104.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

- A. Obtain necessary permits from local Authorities. Ascertain and comply with local requirements for materials, construction and restoration of pavement.

1.03 SUBMITTALS

- A. Shop Drawings: Show fabrication details and connections to adjacent Work.
- B. Submit an Environmental Product Declaration (EPD) from the manufacturer for concrete this specification section, if available. A statement of the contractor's good faith effort to obtain the EPD shall be provided if not available.
 - 1. Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services*.
- C. Product Data: Manufacturer's catalog cuts, specifications, and installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Precast Reinforced Square and Rectangular Concrete Structures:
 - 1. Riser Sections: ASTM C890.
 - 2. Keyed Joints:
 - a. Joint Sealant - Select One:
 - 1) Mortar
 - 2) Rubber Gasket
 - 3) Butyl Joint Sealant
 - 3. Load Rating: AASHTO HS-20 with 30% impact and 130 lb/cf equivalent soil pressure.
 - 4. Concrete for Precast Units: Air content 6 percent by volume with an allowable tolerance of plus or minus 1.5 percent. Minimum compressive strength of 4,000 psi after 28 days.
- B. Frames, Covers and Grates for Catch Basins:
 - 1. Design of each shall be the same throughout the project unless otherwise specified or indicated on the drawings.
 - 2. Units shall meet AASHTO H20 wheel loading requirements. Manufacture, workmanship and certified proof-load tests shall conform to AASHTO M306-89-Standard Specification for Drainage Structure Castings.
 - 3. Material:
 - a. Cast iron: ASTM A48, Class 30B or 35B.
 - b. Delivered to Site free of any coatings, unless otherwise specified.
 - 4. Frames:
 - a. Round with a 30-inch clear opening.
 - 5. Grates:
 - a. Round.
 - b. Minimum open area: 232 sq inches.
 - c. Bicycle safe.

6. Acceptable Catch Basin Frames and Gratings: Pattern R-2557-A frame with Pattern R-2580-A, Type G grate by Neenah Foundry Company, P. O. Box 729, Neenah, WI 54957, (414) 729-3661; Pattern 1187A frame with grate by East Jordan Iron Works, P.O. Box 190, South Bay Rd., Cicero, NY 13039, (315) 699-2601. Corporate Headquarters, 301 Spring Street, East Jordan, MI 49727, (800) 874-4100.
- C. Drop Inlet Frames and Grates:
1. Designed to meet AASHTO H20 wheel loading requirements. Manufacture, workmanship and certified proof-load tests shall conform to AASHTO M306-89-Standard Specification for Drainage Structure Castings.
 2. Material:
 - a. Cast iron: ASTM A 48, Class 30B or 35B.
 - b. Delivered to Site free of any coatings, unless otherwise specified.
 3. Frames: Slab type, 24-inch square clear opening.
 4. Grates:
 - a. Bicycle safe.
 5. Acceptable Drop Inlet Frames and Grates: Pattern R-3562 by Neenah Foundry Company, P. O. Box 729, Neenah, WI 54957, (414) 729-3661; Pattern 1396440 frame with Pattern 1396040 grate by East Jordan Iron Works, P.O. Box 190, South Bay Rd., Cicero, NY 13039, (315) 699-2601. Corporate Headquarters, 301 Spring Street, East Jordan, MI 49727, (800) 874-4100.
- D. Pipe-to-Drainage Structure Connections-One of the following:
1. A-Lok Flexible Connector by A-Lok Products, Inc., 697 Main St., Tullytown, PA 19007, (215) 547-3366.
 2. Lockjoint Flexible Connector by Chardon Rubber Company, 373 Washington St., Chardon, OH 44024, (216) 285-2161.
 3. Kor-N-Seal Flexible Connector by NPC, Inc., 250 Elm St., Milford, NH 03055, (601) 673-8680.
 4. Link-Seal Flexible Connector by Thunderline Link-Seal, Inc., 6525 Goforth St., Houston, TX 77021, (713) 747-8819.
- E. Mortar: ASTM C 270, Type M.

PART 3 EXECUTION

3.01 PREPARATION

- A. Sewer Lateral Openings in Precast and Cast-in-Place Concrete Risers: Provide openings and install pipe connectors in strict accordance with the recommendation of the connector manufacturer.

3.02 INSTALLATION

- A. Construct concrete structures with precast reinforced riser sections to the dimensions shown. Seal joints between precast riser sections with material specified.
1. Wall thickness for circular structures 12 feet deep or less: 5 inches.
 2. Wall thickness for circular structures greater than 12 feet deep: 6 inches.
- B. Position tops of structures flush with finished grade.
- C. Form inverts in manholes on straight runs by the use of channel pipe.
- D. Cut laterals which will enter above the invert to correct length before installation. Do not cut after installation. Construct drops as shown.
- E. Construct drop inlets of concrete or precast units.

END OF SECTION

SECTION 33 40 00
SURFACE DRAINAGE SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Modular trench drain systems.

1.02 RELATED SECTIONS

1.03 REFERENCES

- A. ASTM International (ASTM): ASTM C579 – Standard Specification for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- B. ASTM International (ASTM): ASTM C580 – Standard Specification for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.

1.04 SYSTEM DESCRIPTION

- A. System Type:
 - 1. Sport drain sloping system shall employ an angled grade on both sides of a linear trench to move runoff into a point along the channel. Liquids shall be discharged by gravity flow at the end of the drain into an underground pipe system or culvert.
 - 2. Sport drain neutral system shall provide ample hydraulics for track application.
- B. System Design:
 - 1. Modular trench drains shall be factory manufactured and engineered with compatible grates and accessory components in sizes and capacities to provide a complete functioning trench drain system.
 - 2. Modular channels are aligned onsite via male/female interconnecting ends to form a continuous run. Systems shall provide a perimeter of drainage around running track/field.
- C. System Requirements:
 - 1. Loading: Pedestrian
- D. Durability:
 - 1. Liquid Type: stormwater runoff
 - 2. Grade Surface Adjacent To Trench Grate:
 - 3. Grate and trench materials shall resist Liquid Type attack and corrosion of trench drain components and grate.
- E. User Requirements:
 - 1. Grate Finish: Galvanized Steel
 - 2. Grate Safety Requirements:
 - a. Grates shall comply with requirements of the Americans with Disabilities Act (ADA).
 - b. Grates shall include a 'heelsafe' pattern in compliance with American Society of Mechanical Engineers (ASME) A112.6.3, Floor and Trench Drains. Section 7.12, "Heel Resistant Strainers and Grates,
 - c. Grates shall prevent small stiletto-style heels from getting stuck, causing injury or falls.
 - d. Grates shall be bicycle-safe grates to avoid slot openings that trap modern bicycle wheels.
 - e. Hydraulic Performance:
 - f. Trench drain system shall provide drain performance without grate bypass occurring and without uncontrolled ponding during maximum design flow rate and duration.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01300.

- B. Product Data: Submit product data and installation instructions including manufacturer's product sheet, for specified products.
- C. Shop Drawings: Submit shop drawings showing layout, profiles and product components, including anchorage, accessories, finish colors, patterns and textures.
- D. Quality Assurance Submittals: Submit the following:
 - 1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
 - 2. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- E. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- F. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square representing actual product, color, and patterns.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 5 year experience manufacturing similar products.
- B. Installer Qualifications: Installer experienced in performing Work of this section who has specialized in installation of work similar to that required for this project.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with Division 01 Product Requirements Sections.
- B. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- D. Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.08 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.09 SEQUENCING

- A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.
- B. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.10 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
- B. Manufacturer's Warranty:
 - 1. Warranty Period: 12 months commencing on Date of Substantial Completion or 24 months from date of purchase, whichever is sooner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer:

1. ACO, Inc.; 9470 Pinecone Dr., Mentor, OH 44060. ASD. Toll Free Tel: (800) 543-4764. Tel: (440) 285-7000. Fax: (440) 285-7005. Email: info@acousa.com. Web: <http://www.acousa.com>.
2. ACO, Inc.; 825 W Beechcraft St. P. O. Box 12067, Casa Grande, AZ 85122. Tel: (520) 421-9988. Fax: (520) 421-9899. Email: info@acousa.com. Web: <http://www.acousa.com>.

B. Requests for substitutions will be considered in accordance with provisions of Section 012500.

2.02 SYSTEM DESIGN:

- A. Load Class: Provide trench drain system designed, engineered and installed to support the minimum loads as defined by EN1433. Load Class shall be: Load Class A
- B. Grate Design: Safety.
 1. Grates that comply with requirements of the Americans with Disabilities Act (ADA) of 1990 are available.
 2. Other safety-focused grates include a 'heelsafe' pattern in compliance with American Society of Mechanical Engineers (ASME) A112.6.3, Floor and Trench Drains. Section 7.12, "Heel Resistant Strainers and Grates,
 3. Grates are designed to prevent small stiletto-style heels from getting stuck, causing injury or falls. In addition, bicycle-safe grates avoid slot openings that can trap modern bicycle wheels.

2.03 SPORT SYSTEM – SPORTS ARENA DRAINAGE.

- A. Product: System 4000 as manufactured by ACO, Inc.
 1. System 4000 – Straight drainage system with grates
 - a. Common uses
 - 1) Running tracks
 - 2) Team facilities
 - 3) Tennis courts
 - 4) Other recreational areas
 - b. Multiple channels
 - c. Multiple grates
 - d. In-line catch basin
 - e. Optional TPE cellular rubber edge for athlete's safety.
 - f. System provides complete drainage for multiple recreational uses.
 2. System 4000 Channels
 - a. Available in one meter (39.37") and in half meter (19.69") lengths.
 - b. Meter (39.37") long channels are either neutral or sloped.
 - c. Half meter (19.69") channels are all neutral channels.
 - d. Sloped channels provide a continuous slope of 100 feet (30m) long.
 - e. Neutrals can extend the run.
 - f. 4" (100mm) internal width
 3. System 4000 Catch Basin
 - a. In-line Catch Basin 4" Internal width
 - b. Plastic trash bucket acts as a sieve to collect debris.
 - c. 4" and 6" drill outs for pipe connections.
 4. System 4000 Grates
 - a. Steel Slotted – 39.37"(1000mm)
 - b. Steel Slotted – 19.69" (500mm)

2.04 MATERIALS

- A. Polymer Concrete: Durable material which is resistant to road salts and common chemicals, made from polyester resin reinforced with mineral aggregates and fillers.
- B. Galvanized steel: Commercial steel, ASTM A653/A653M.

- C. Stainless Steel: Type 304, ASTM A240/A240M
- D. Polyethylene

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 Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved submittals. Install in proper relationship with adjacent construction.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

**SECTION 334104
CORRUGATED POLYETHYLENE STORM DRAIN PIPE**

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Earthwork: Section 310000.
- B. Drainage Structures with Frames and Covers: Section 333913

1.02 SUBMITTALS

- A. Product Data: Manufacturer's specifications (AASHTO M-252 or AASHTO M-294), including dimensions, allowable height of cover information, and installation instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Advanced Drainage Systems, Inc., 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051.
- B. Hancor, Inc., 401 Olive St., Findlay, OH 45840; (800) 847-5880.

2.02 MATERIALS

- A. Corrugated Polyethylene Pipe and Fittings: Conform to AASHTO M-252 (4 to 10-inch diameter) or AASHTO M-294 (12 to 36-inch diameter).
 - 1. Coefficient of Roughness (interior pipe surface): 0.020 maximum (Manning formula).
 - 2. Classification: Type C.
 - 3. Design Strength (all sizes): 50 feet allowable height of cover.
 - 4. Joint Couplings: Polyethylene Couplers; snap-on type or split collar through 24-inch diameter, screw-on type where applicable.
 - 5. Material Properties: High-density polyethylene meeting the requirements of ASTM D 3350, Cell Classification 324420C; or ASTM 1248, Type III, Class C, Category 4, Grade P33.
- B. Corrugated Polyethylene Pipe (Smooth Interior): Conform to AASHTO M-294 (12 to 36-inch diameter).
 - 1. Coefficient of Roughness (interior pipe surface): 0.012 maximum (Manning formula).
 - 2. Classification: Type S.
 - 3. Minimum Pipe Stiffness Values:

DIAMETER	PIPE STIFFNESS (PER ASTM D 2412)
4", 6", 8", 10", 12"	50 psi
15"	42 psi
18"	40 psi
24"	34 psi
30"	28 psi
36"	22 psi

- 4. Joint Couplings: Polyethylene Couplers; snap-on type or split collar through 24-inch diameter, screw-on type where applicable.
 - a. Corrugated to match pipe corrugations, width not less than one half pipe diameter.

- b. Split couplings shall engage an equal number of corrugations on each side of the joint.
- 5. Joint Couplings: Polyethylene, bell-and-spigot type couplers utilizing an elastomeric gasket conforming to ASTM F 477.
- C. Fittings:
 - 1. High density polyethylene meeting the properties specified for the pipe.
 - 2. Either molded or fabricated.
 - 3. Designed specifically for the pipe furnished and manufactured by the pipe manufacturer.
- D. Headwalls and End Sections: Galvanized steel manufactured from material meeting the requirements of AASHTO M-218.
 - 1. Conform to shape, dimensions, and thickness shown on the drawings.
 - 2. Use only extra length rod and lug-type, galvanized coupling band connectors.
- E. Perforated Pipe: Conform to AASHTO M-252 or AASHTO M-294, Type SP with Class I perforations.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Laying: Lay pipe to indicated line and grade with a firm uniform bearing for the entire length of the pipe. Fill excess excavation with suitable materials and tamp.
- B. Joints: Install coupling and fasten per manufacturer's instructions.
- C. Connections:
 - 1. Make connections to existing pipe by using a galvanized steel "dimple"-type coupling. Remake damaged existing joints.
 - 2. Make connections to existing manholes and drainage structures by cutting into the floor or bench of the manhole or drainage structure and forming a new channel.
 - 3. If the pipe, manholes or other structures with which connections are to be made have not yet been installed, install the pipe to a point directed by the Director's Representative and plug or cap the end in a satisfactory manner.

END OF SECTION